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International Marine Engineering

SEPTEMBER, 1906.

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NEW ATLANTIC LINER EMPRESS OF IRELAND.

BY ALLAN McPHERSON.

The new twin screw steamer *Empress of Ireland,* built by the Fairfield Shipbuilding & Engineering Company, Limited, Glasgow, for the Canadian Pacific Railway Company, has carried out most successful trials on the Firth of Clyde, and the highly satisfactory speed of 20 knots has been attained. The tests included progressive runs over the measured mile at Skelmorlie, which were followed by twelve hours full speed and twelve hours coal consumption trials, the whole of the trials being carried out without stoppage.

The keel of the *Empress of Ireland* was laid in May, 1905, so that only eight months were required to bring her to the launching stage, in January, 1906. This vessel is the greatest launching weight ever put into the water by the Fairfield Company.

THE CANADIAN PACIFIC STEAMSHIP EMPRESS OF IRELAND, AT SEA.

The ship is of the following dimensions:

Length over all	570 feet 0 inches.
Breadth molded	65 feet 6 inches
Depth to upper deck	40 feet 0 inches
Draught, loaded	28 feet 0 inches
Displacement in tons	20,000
Indicated horsepower	18,000
Gross tonnage	14,500

The keel is 3 inches in thickness, and there is a double bottom for water ballast to bring the ship to a draught that will obviate rolling or pitching. The total capacity for water ballast is 3,490 tons. Very deep bilge keels have been fitted for one half the length of the ship, and there are nine watertight bulkheads across the vessel from keel to upper deck, and so arranged that should any two compartments be filled with water the ship would remain afloat.

The ship, which is a sister of the *Empress of Britain,* described at page 16 in our issue for January, 1906, is built to Lloyds 3 deck and shelter deck 100 A 1 class, and has eight decks. The decks are named in the following order from above: boat deck, upper promenade, lower promenade, shelter, upper, main, lower, and orlop deck. All the decks are plated and covered with teak where exposed, and with yellow pine where not exposed to the weather. She has two pole masts, fore and aft rigged, with derricks, spars and other appliances for dealing with cargo.

The passenger accommodation has been admirably arranged. There is provision for 310 first class passengers, 500 second, 500 third, and 270 steerage, a total of 1,580. The lower and upper promenade decks are entirely devoted to first saloon passengers. The state rooms are fitted up in a most luxurious manner, and the walls and ceilings of each pair have been treated differently, some being hung with tapestry, and others panelled in satinwood, etc., with upholstery to match. The rooms are well lighted, and the passenger can, at will, have a light at almost any place convenient to himself. The bath rooms and toilet arrangement in the ship have received special attention, and are distributed throughout in the most convenient positions.

Commencing with the upper promenade deck, amidships is the first saloon entrance. It has a handsome staircase leading to the lower promenade deck, and from there to the shelter deck. The staircase is panelled in dark colored polished teak, and is lighted by a large dome above, with leaded glass panels. Aft, and within easy access of the entrance on upper promenade deck, is the music room, which is treated in a light and airy style. The walls are exquisitely panelled in satinwood, and broken by pilasters richly carved and fluted. The ceiling is finished in white

THE CAPTAIN'S BRIDGE VIEWED FROM FORWARD.

and gold, and the room is flooded with soft light from the artistic dome above, with its tastefully designed leaded glass panels. The grand piano and the furniture of the room are carried out in satinwood. The rich carpet is of a soft green shade, and the settees and easy chairs are upholstered in velvet of the same color. A charmingly designed mantelpiece, with artistic brass sides and canopy, adds to the appearance of the room. The deep oriel bays at each side, with their inviting

THE FIRST CABIN SMOKING ROOM.

settees and cosy corners, all tend to suggest that the passenger is in a modern hotel, rather than voyaging across the Atlantic.

The café, which is one of the latest features in up to date ships, is situated on the lower promenade deck, immediately below the music room. The paneling is framed in Italian walnut with tapestry panels, and the settees and chairs are upholstered in a pleasing shade of green velvet. The floor is laid with interlocking rubber tiles, green and white. In the center of the room is the well over the first class dining saloon.

Forward of the café, on the same deck, is the library. This is a very comfortable apartment, framed in rich mahogany, with Amboyna panels, and there is a large book case and other furniture to match. The settees and easy chairs are upholstered in green velvet, and the floor is laid with a rich carpet.

Aft of the café is the first cabin smoke room, which is large and commodious, and well lighted, having large square windows around the sides and a rectangular well above, with ornamental fretwork and provision for ventilation. The walls are framed in oak with hammered brass panels. The settees and chairs are upholstered in brown leather, and the floor is laid with interlocking rubber tiles, brown and white.

On each side of the lower promenade and upper promenade decks amidships is a clear promenade of 10 feet 6 inches for the first saloon passengers. The lower promenade deck extends right aft to the stern of the ship. This is a feature introduced for the first time into ships of this class, and forms a splendid open promenade.

On the deck below, which is the shelter deck, leading from the main staircase there is the first class dining saloon. This room is situated forward of amidships, extends the full width of the vessel, and is 58 feet long. The full complement of saloon passengers will be able to dine at once. In the center of the saloon are four large dining tables running fore and aft, and at the

THE FIRST CLASS DINING SALOON, WITH SIDE ALCOVES.

ship's side in alcoves there is an entirely new arrangement of dining tables, each table being of the horseshoe shape, and seated for five persons, the five seats form a semicircle around the tables being of the latest tip-up opera house style.

In each alcove along the ship's side are two large windows with ornamental shutters, which, together with a large oval dome overhead in the center, afford splendid light to the saloon. The paneling is in mahogany, enameled white above, with carving in old gold; the ceiling also is in white and gold. The furniture is upholstered in light crimson leather, harmonizing with the Turkish carpet runners on the floor. At the fore end is a piano, and at after end a large sideboard.

Aft of the first class dining saloon are the pantries, with the various galleys, bake house, bakers' shop, confectionery, etc., forming one large kitchen, equipped with the best cooking apparatus that can be devised. Among other devices arranged in the galleys are machines for making sandwiches, for cutting bacon, for boiling eggs, and also for washing dishes.

Forward of the first class dining saloon, is a separate dining saloon for children. The room is tastefully arranged with pictures around the walls. The tables are fitted with revolving chairs, and the upholstery is in crimson leather.

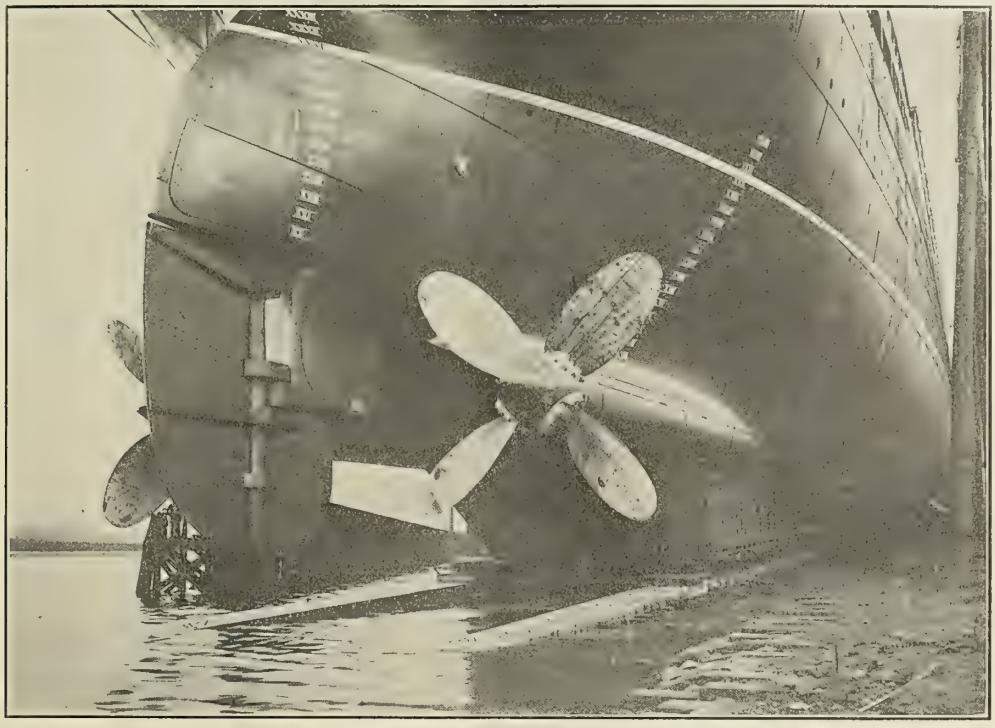
The second class apartments are on the shelter deck,, and are hardly inferior to those provided for first class passengers. Indeed, the saloons and state rooms on this ship are an improvement on the first class accommodation on many vessels at present crossing the Atlantic.

The second cabin dining saloon will seat about 300 persons, and is fitted with alcoves at the sides, after the style of the first saloon. The walls are paneled in light mahogany, with furniture to match. This room also extends the entire width of the ship. Through double swinging doors at the after end the social hall is reached. The walls of this room are framed in light oak, with light oak panels below, and bird's-eye maple panels above.

Leaving the social hall and crossing the shelter deck, which is entirely sheltered by the lower promenade deck, a passenger comes to the second cabin smoke room. This room, like the first class smoke room, is arranged with cosy corners, arm chairs and small tables.

Leaving the shelter deck by one of the many stairways the upper deck is reached. This deck has two side passages fore and aft; the one on port side is divided off for use of the ship's company, and working the ship generally, while that on the starboard side is arranged for the accommodation of first and second class passengers. A nursery fitted up in simple style is provided for the use of children.

Below the upper deck is the main deck, where the majority of the second class state rooms are situated. These are comfortable rooms sleeping two, three or four persons, and fitted up somewhat similar to first class state rooms.



THE STERN OF EMPRESS OF IRELAND BEFORE LAUNCHING, SHOWING PROPELLERS.

On the main deck forward, the third class passengers are berthed in cabins accommodating from two to six passengers. There is a large dining saloon for third class, capable of dining 300 persons. The tables are fitted with revolving chairs, and a piano and sideboard, etc., are provided. From stairways in each compartment passengers can reach the promenade on the upper deck, which is covered, or the open promenade on shelter deck.

On the upper deck forward is the third class smoke room and third class ladies' room, both of which are fitted in a most comfortable manner; also a play ground is provided for children. On the main deck forward and on the lower deck provision is made for steerage passengers in open berths, with ample dining

THE MUSIC ROOM, ON UPPER PROMENADE DECK.

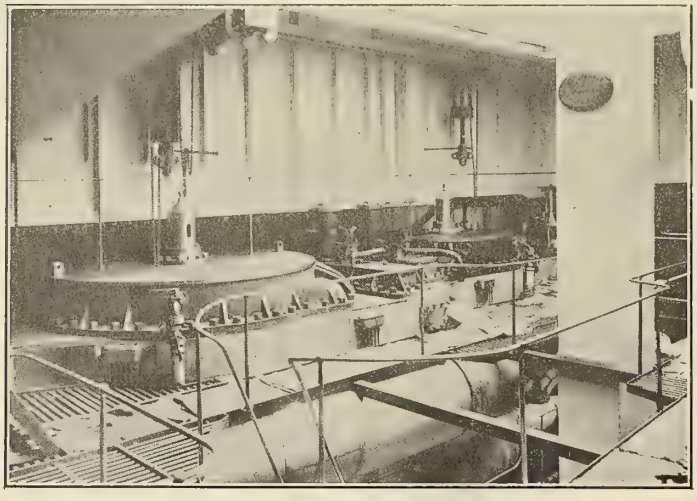
THE LIBRARY AND WRITING ROOM.

accommodations and all conveniences which tend to their comfort.

There are also arranged at suitable parts of the ship a hospital, dispensary, printing room, hairdressers' shop, mail room and specie room. Wireless telegraphy is arranged for, and a suitable house is fitted out on upper promenade deck for the receipt and dispatch of messages.

Part of the lower deck and all of the orlop deck is cargo space, and two of the 'tween deck holds are insulated for carrying frozen meat.

Special consideration has been given to the ventilation of the ship, and the thermotank system has been adopted as the most efficient. There are eighteen thermo tanks, suitably placed, to supply either heated or cold air, or to extract foul air from any part of the ship. In addition to the thermotank system. electric fans have been fitted in the public rooms and galleys. There is a complete installation of electric light, with generating plant consisting of three independent engines and dynamos, providing power for a liberal number of lights in all compartments, especially the public rooms.



THE UPPER PORTION OF THE ENGINE ROOM.

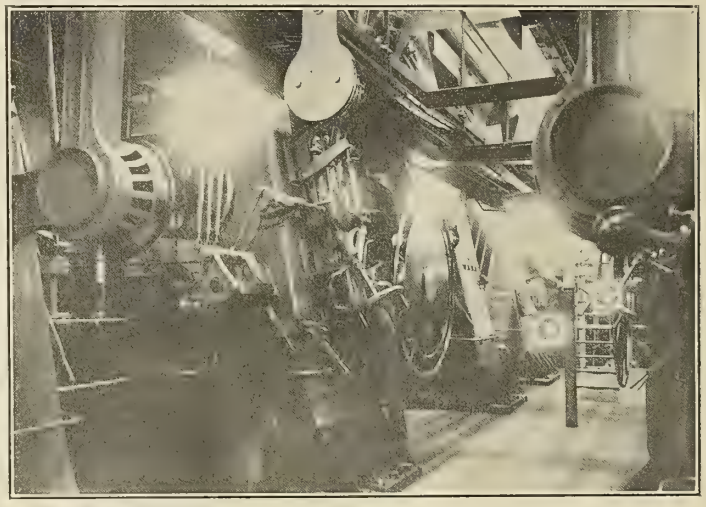
There are twelve cargo winches and two boat hoists, the driving gear of the winches being so arranged that no noise is created while working.

The propelling machinery consists of two sets of quadruple expansion engines, each set having 4 cranks, balanced on the Yarrow, Schlick, Tweedy system, and each engine, running at 80 revolutions, indicates over 9,000 horsepower. The cylinders are 29, 48, 63 and 96 inches in diameter, the stroke in all cases being 54 inches. The two propellers are 19 feet in diameter and have each four blades of manganese bronze. The crank shafts, the thrust, tunnel and propeller shafts are of forged mild steel.

All the auxiliaries are separately driven, including the air pumps. There are for each engine two condensers, each with separate pumps, and thus the liability of complete breakdown is greatly reduced. The condensing water is circulated through the condensers by two centrifugal pumps. The engine room is fitted with all modern appliances, including two evaporators, working in combination with two distillers for supplying fresh water to the ship and boilers.

There are six double and three single ended boilers of the ordinary multitubular type, adapted for a working pressure of 220 pounds per square inch. These are placed in two boiler-rooms, with a large coal bunker between. The double ended boilers have each eight furnaces, and the single ended, four furnaces. These give a total grate surface of 930 square feet, and a heating surface of 42,600 square feet (ratio 45.8 to 1), and are arranged to work with Howden's forced draught.

The engines during all the trials worked most satisfactorily, alike in respect to power and economy, and on four runs at full power the mean of mean speeds was a fractional point over 20 knots. The speed guaranteed in the contract was 19¼ knots, and



STARTING PLATFORM, ENGINE ROOM OF EMPRESS OF IRELAND.

the vessel was required to carry on a mean draught of 27 feet 6 inches, a cargo of 6,500 tons, in addition to the coal and stores required for the transatlantic trip.

ON PIPING AND POWERING OF SHIPS.

BY G. E. SMITH.

In the subject of ship design the arrangement of the auxiliary machinery in the ship is usually left, except in a very general way, until the structural work has progressed so far as to make much changing out of the question. This is a great oversight. By a careful study of the conditions in the vessel under consideration, the auxiliaries can be located so as to reduce the amount, and increase the efficiency, of piping and connections, very materially. The modern method of shop design is to arrange machinery, etc., in general, so as to start the raw material in at one end and turn out the finished product at the other. This same ruling should apply as far as possible to the machinery of a ship. The steam, starting at the boiler, should go direct to the engines, the latter preferably designed with the high pressure cylinder nearest the boiler room. (The location of the cylinders in the engine is of course a matter which depends largely on the design of the engine itself).

The main condenser should ordinarily be aft, in a vessel fitted with screw propellers, with the circulating pump and connections at its after end. The channel way from condenser should lead forward to the main air pump, the discharge from the air pump leading forward to the main feed tank. The suction from main feed tank should carry out the same idea, and lead forward to the main feed pumps located at forward end of the engine room; from here the feed lines, leading forward, still, go to boilers. In this way pipes do not return on each other, and we have a complete loop from and to the boilers.

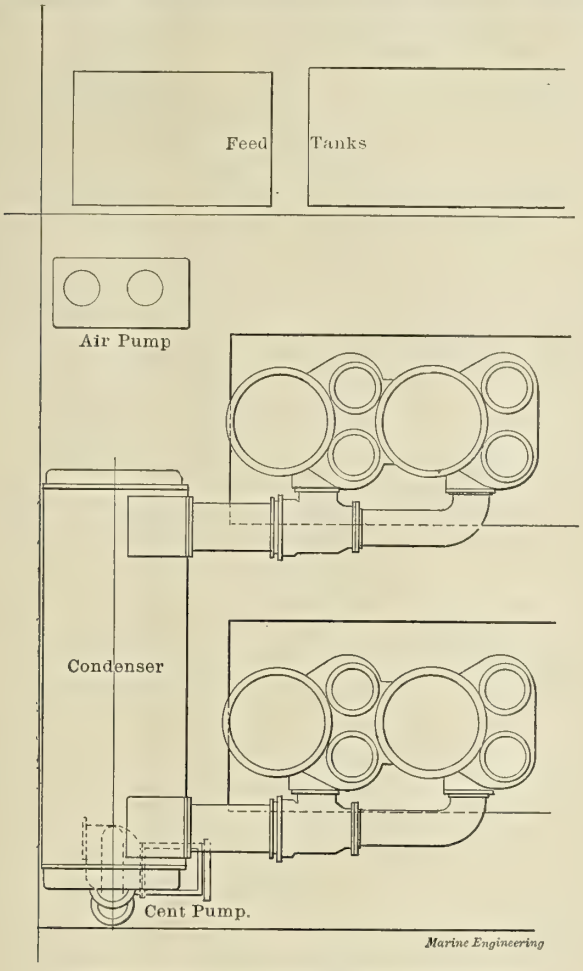
The above remarks of course apply in a general way only, as modifications are frequently necessary owing to a saving in one direction offsetting one in another. By placing a pocket in a bunker or cargo space for small machinery, we frequently can gain much valuable passage room. Great care should be exercised in locating the machinery to insure the "get-atableness" of all parts. See that all condenser tubes can be readily removed without taking down parts of the other machinery or piping.

All valves must be in easy reach for operation or repair, bilge boxes and manifolds where they can be readily cleaned; oil boxes and tanks where the men can properly attend to them. Pumps,

blowers and other auxiliary machinery must be located so that piston rods, valves, etc., can be easily reached for repairs, and so that the machinery can be taken apart without interfering with the neighboring pipes and fittings.

An outline sketch of ladders and gratings should be gotten out before any machinery is permanently located, and especial care given to clear passages and location of ladders, to give easy access to and exit from boiler and engine rooms.

Other points, usually left until later, which should be carefully planned out in the early stages are, the hoisting gear for cylinder and condenser heads and the location of counters, gages and telegraphs. If possible the counters, clocks and gages should



ARRANGEMENT FOR ONE CONDENSER WITH TWIN SCREWS.

be located on one gage board in view of and near the working platform, and the log desk should be placed close by.

In fast twin screw ships of small type, where there is not an abundance of spare width, a most satisfactory solution, where the length of the engine room is available, is to use one condenser placed athwartship near the after engine room bulkhead, and connect both engines to it, with circulating pump and dynamos on one side, and air pump and tanks on the other. The condenser is something which rarely gives trouble if properly designed and installed, therefore the objection which is raised regarding one condenser for two engines, that in case of accident to the condenser both engines are out of service, is hardly a valid one. In a single screw ship but one condenser is used, and a stoppage due to condenser troubles is most rare.

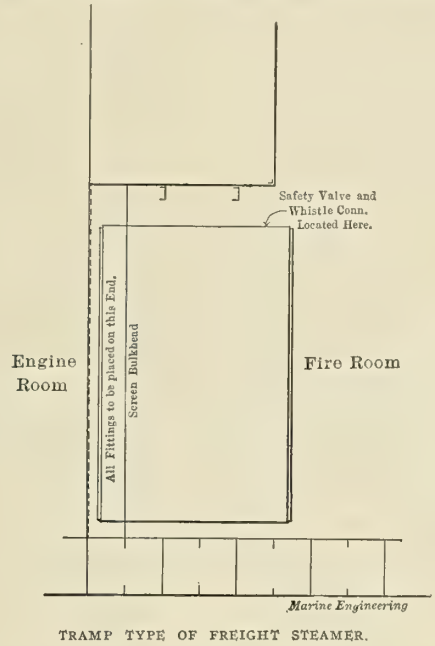
A single feed and filter tank is also frequently a space saver. By installing one tank with discharge from both air pumps on one side of the ship, the corresponding space on the other is available for evaporators, dynamos, or for whatever else it may be needed.

The blowers should also be sketched in position, together with the duct to the air boxes, if the Howden system is used. In locating the blowers care should be taken to keep the engines entirely out of the boiler room, or at least in a space easily ventilated and which can be kept at a livable temperature. Where the engines are kept entirely outside of the boiler room all trouble from coal dust in the bearings is eliminated and the heat is reduced. A good arrangement is to have the engines in a compartment open to the engine room, and the blowers in the boiler rooms connected by properly supported shafting to the engines.

The ash hoists, railways, ejectors and ventilators should be lined in and carefully designed at the start. By getting all these arrangements under way and advancing them far enough to see just what difficulties must be met, each part can give a little to the other, and the result is a well balanced whole, instead of half the work having an undesigned appearance.

Before the run of main steam is decided, the smoke boxes, uptakes and smoke pipe should be sketched in with care as to the areas at the various points, and the upward lead should be always at least 30 degrees to the horizontal.

The constructor, in order to increase to the greatest possible degree the cargo carrying capacity, is prone to cut down the size of the boiler hatch below proper limits. In many cases when the expert is called in by ship owners to tell why his ship



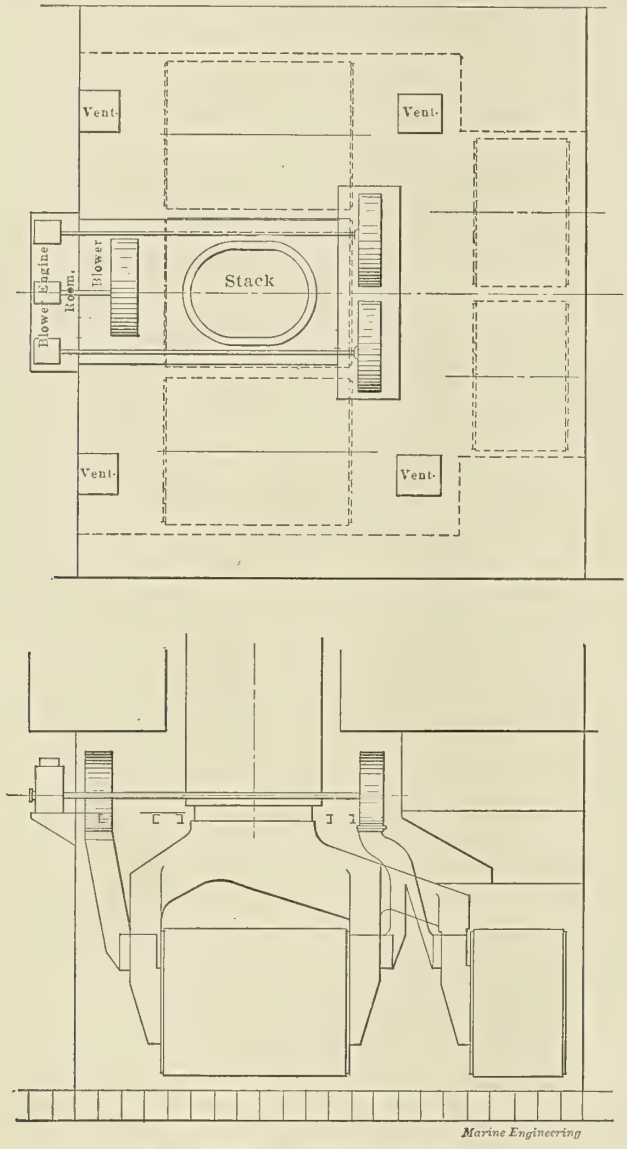
TRAMP TYPE OF FREIGHT STEAMER.

costs so much to run, the trouble is apparent as soon as the engineer looks inside the hatch. The hatch is so small that the leads from the boilers to the stack are flat, and frequently circuitous, and the result is poor draft conditions. On one job the writer has in mind the leads were perfectly horizontal, the areas low, and even under these conditions the clearance between the coaming and the uptake was but one quarter inch. Imagine the cost of templet and fitting of this plate work. This was paid for twice, as in overhauling, new boilers were installed, and new uptakes and stacks, and as the ship work was not altered the plant had to be duplicated. Properly designed hatches and uptakes would have saved the builder on his original cost, and the owner on his coal bills, to a degree probably considerably in excess of the returns from cargo stowage.

The owner is not impressed by the large horsepower furnished by the engine, or the horsepower per pound of fuel consumed; such points are interesting to the engineer only. What the owner wants is small operating expenses with large freight returns, and to get this the machinery plant must be economical,

and the lines of the ship such as to bring the largest carrying capacity with the least amount of propulsive power. Model experiment helps to solve the problem of least propulsive coefficient. If owners would take up the matter with the expert in the preliminary stages, stating the conditions under which his ships are to be run, as to speed, average cargo, stowage of cargo, etc., he could get advice as to the best compromise which will give the largest return on money invested. The cheapest boat is not necessarily the most economical, and the large, high priced ship not always a money saver. The contractor is frequently not in a position to give unbiased judgment.

Economy of ships is a subject most complex in some ways



SKETCH SHOWING ARRANGEMENT FOR BLOWERS.

and yet is a most interesting and profitable one to the ship owner as well as to the naval architect and engineer.

In Germany the subject is being studied, and, while great economy has not been reached, the tests, on the larger ships at least, have proved the correctness of the preliminary calculations, while in the majority of cases in this country the resulting horsepower, coal comsumption, etc., have been quite different from expectations. Sometimes the economy has been greater, but in most cases much less, than contemplated. The reason for this usually is that the calculations have not been taken up in a sufficiently detailed manner to take account of clearance spaces, cylinder ratios, steam drop, friction of parts and other points. Sometimes the type of engine is not adapted for the particular service required.

It is to be hoped that the whole subject will receive greater attention from ship owners in the future than in the past, and that eventually the economy of the stationary service will be reached.

In taking up the piping arrangement the first thing planned out should be the main steam pipe. Great care should be exercised in this work to be sure that the best possible solution is found. The run should be as flexible as may be, yet have few bends and fewer expansion joints. Cut out the latter whereever possible, as they are invariably a source of trouble and annoyance.

With the foregoing properly blocked out, the detail of the design may be taken up with the assurance of first class results. Above all keep in mind that the less the amount of piping and fewer the valves and fittings used, provided all necessary connections can be made, the more efficient the system. This has the additional advantage of less joints to keep tight, less original cost, more satisfaction to engineer and owner, and this is the ideal arrangement.

For a small cargo ship where two single ended boilers are used, the ideal solution is the English tramp type modified. That is, back the boilers into the engine room, and place a screen bulkhead about 18 inches forward of the back head of the boiler. On the back of the boiler and the 18-inch exposed space all the fittings, including the gage glass, can be located, and every valve, except the whistle and safety valve, is under the direct care of the engineer. This arrangement gives greater cargo capacity, reduced operating crew, and keeps the engineer in close touch with everything.

This in a general way covers preliminary design.

Taking up the design in detail, the boiler naturally comes first. The scantlings of the boiler are so almost entirely governed by the rules of the Steamboat Inspectors and of the various insurance societies that their discussion does not belong here. A few points may be worthy of notice, however. Referring to the Scotch boiler (this being the usual type designed by shipbuilders, the water tube being furnished complete by subcontractors) be sure that ample steam space is provided above the tubes. About one-third the diameter of the boiler is a good height to leave for this purpose. Locate manholes and handholes so that every part of the boiler can be reached for cleaning. Design the furnaces so that they can be readily and cheaply removed in case of collapse. Provide separate and distinct stop valve and internal pipe systems for the main and the auxiliary feed connections. Frequently a boiler is entirely thrown out of service by accident to one or the other, where a single connection is used for both. In locating single ended boilers in the ship, provide ample room (say 20 to 24 inches in the clear) between the boiler and the bulkhead, so the workmen can get at the stays and calking edges to properly repair them when necessary. Provide internal dry pipes for both auxiliary and main steam connections, where they have separate attachment to the boiler.

In the design of the uptakes, easy upward leads with areas not less than one-fifth of the grate where forced draft is used, and one-sixth for natural draft, will be found advantageous from the economical standpoint.

In arranging the piping systems in the boiler room, locate only absolutely necessary valves there; wherever possible put the connections in the engine room. The leads in the boiler room should be short and direct, with valves close to or in the passages, where they can be seen and reached by the water tender in his regular tour of duty. The more easily the valves and connections can be examined the better care will be taken of them by the men. In the main and auxiliary feed and boiler blow and pumping out systems the valves on the boilers should be the only ones in the boiler room, and in the tramp type already referred to, not even these. Pressure lines of all kinds should be above the floor and kept out of the bunkers. Run

pipes between boiler rooms and engine rooms in passages, where possible; it is not especially conducive to good temper to find it necessary to trim many tons of coal in the bunkers in order to get at a leaking joint box inside. Engineers should insist on this point being kept in mind by designers.

In ventilating the boiler rooms, care must be taken that at least all points which must be visited by the men are carefully ventilated. Donkey boiler and blower spaces should be most carefully looked into in this matter.

The whistle pipe should have direct connection to at least two of the boilers at the forward end of the boiler room, and likewise be connected to the auxiliary steam line. The leads of these pipes should be as nearly vertical as possible, so that no accumulation of water can take place, all being drained direct to the boilers.

Where there are two stacks, a single escape pipe, carried up the forward side of the after stack, is frequently the best arrangement. The area of this pipe should be about 60 percent of the combined area of the outlets from all the boiler safety valves connected to it.

Vertical ladders from the firerooms are usually the best, as they take up less room and firemen in many ways prefer them. Ladders, where angled, should be about 30 degrees from the vertical, in boiler or engine rooms. Be sure that every valve can be reached from the floor or grating. With these general hints, we will leave the boiler room and proceed to discuss the engine room in detail. As this is not a treatise on steam engineering, only odds and ends of design, where faults are likely to creep in, are mentioned.

We will assume that the main engine has been located with due care as to proper passages around it, and as to location of foundation bolts in ship floors. In designing the engines, clearances are unfortunately given small consideration. In engines designed a few years back, and still being built from the old patterns, clearances at times amount to 30 or 40 percent. This entails a large waste of energy, and results in reduced economy. Now the ship owner is looking to his pocket book and if he obtains a ship which is especially economical in the matter of coal and supplies, he will endeavor to duplicate it at the earliest opportunity. Therefore it pays to redesign, and most carefully, all plans of engines to be built, and see if the economies of land practice cannot be duplicated. The reciprocating parts should be balanced as far as possible by proper weight of pistons. This is important in small engines, though in large ones not so much so, owing to other conditions arising, of greater importance.

The use of manifold valve boxes, instead of a series of valves in pipe lines, is a space saver, and makes a much handier arrangement for the engineer, besides reducing the number of flange joints to be cared for. This especially refers to the suction and discharge from feed and donkey pumps, although in some cases, as in dynamo rooms and similar arrangements where a group of machines is located, it is also advantageous for steam.

In the design of the condenser, baffle plates, carefully located to give the best distribution of the exhaust steam, will greatly improve the vacuum conditions and resulting economy. The condenser should be allowed ample cooling surface. Economy in the size of the condenser does not improve the economy of operation. An allowance of 1.3 square feet for triple, and 1.4 to 1.5 square feet for compound engines per horsepower will give good results. The circulating pump should have a short, straight connection to the sea and be located if possible, under the condenser, discharging by a short, straight lead directly into the water head.

While these hints are theoretically correct, so many conditions arise to alter them that no general rules can ever apply. More care and interest should be taken in the detail parts of a machinery and pipe arrangement by the chief draftsman and his assistants. The whole is usually left to the draftsman in charge, with the result that many small points are slighted. Inspectors and engineers, representing the owners of ships building, should most carefully study the proposed arrangement, so that changes for the better can be made on the drawings, instead of waiting until things are installed, when the expense of change is prohibitory.

THE ENGLISH SCOUT CRUISER ATTENTIVE.

We present herewith a photograph of one of the latest cruisers of this type, there having been constructed for the English navy in the last three years not less than eight of these vessels, which are almost duplicates in design, speed and power. The *Attentive* is a sister ship of the *Adventure,* both of which were built by Sir W. G. Armstrong, Whitworth & Company, Limited, at Elswick. The displacement is 2,750 tons; length, 370 feet between perpendiculars; beam, 38 feet, and normal draft, 13 feet 3 inches. The twin screw engines are of 17,000

THE ENGLISH SCOUT CRUISER ATTENTIVE.
(Copyright, 1906, Cribb, Southsea.)

indicated horsepower, and are supplied with steam by Yarrow boilers, the designed sea speed being 25 knots. This was somewhat exceeded on trial.

The *Attentive* carries a battery including ten 12-pounders and eight 1-pounders, the main purpose of which is for use against hostile torpedo destroyers and torpedo boats which might attempt to interfere with her keeping in touch for scouting purposes with the enemy's fleet. In addition to the guns, the vessel carries two 18-inch Whitehead torpedo tubes, with torpedoes of a maximum range of four thousand yards.

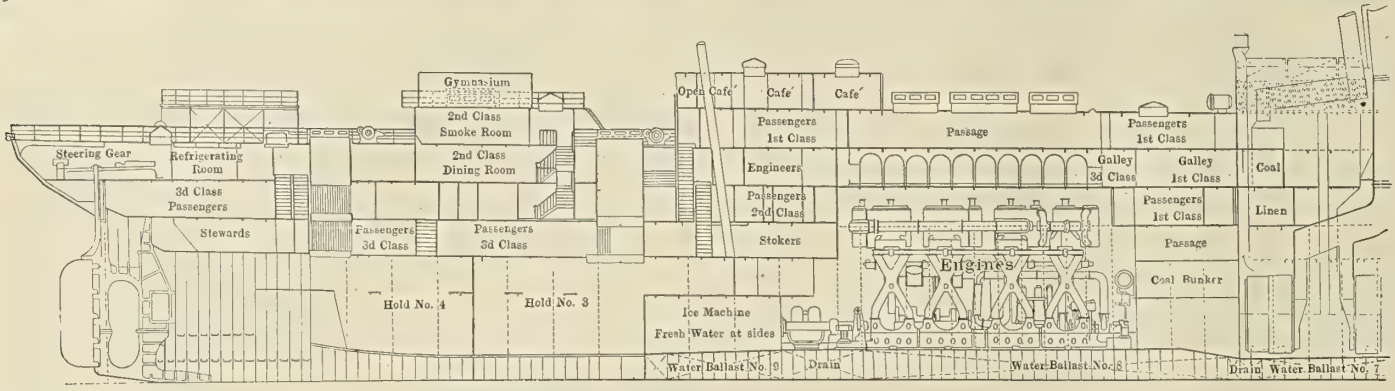
It will be noted in the photograph that the bow is given a very considerable flare, for the purpose of throwing off waves which might otherwise have a tendency to climb on board; this should keep the ship fairly dry, and add much to the comfort of those on board. The complement consists of 268 officers and men. The cost of the vessel complete is understood to have been about £275,000 ($1,350,000). No armor is carried except a deck 2 inches thick on the slopes and 5/8-inch on the flat.

It is reported, and denied, that the Hamburg-American Line has given a contract to Harland and Wolff, of Belfast, for a ship larger than the Cunarder *Lusitania.* One report is that the ship is also to be faster than the English flyer.

LA PROVENCE.

We have already given this ship a fairly comprehensive description,* hence will confine the present information to that not previously covered.

It is interesting to notice that out of the total displacement of 19,160 tons no less than 77 percent is required for the fixed weights of hull, machinery, equipment, fittings, etc., leaving only 23 percent, or about 4,400 tons, for the movable weights. Of this latter amount, some 3,500 tons comprises the necessary coal supply for the voyage, while the remaining 900 tons only is available for cargo, provisions, stores and passengers, this being 4.7 percent of the displacement. The capacity of the holds for merchandise is 2,320 cubic meters. In addition to this, there is a capacity for 1,655 cubic meters of merchandise or cargo in the compartments devoted otherwise to steerage passengers.

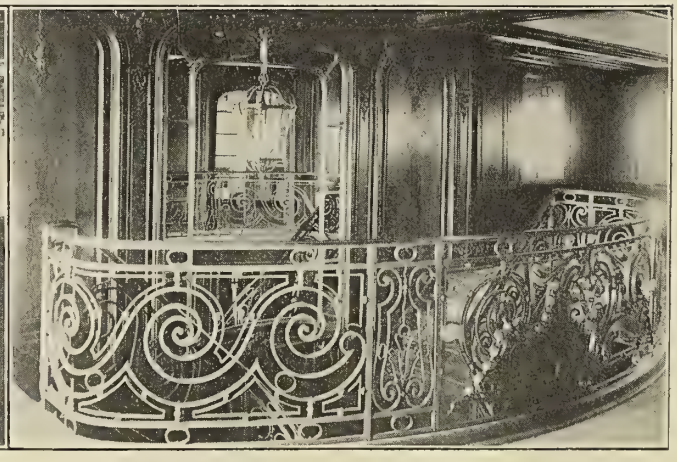


LONGITUDINAL SECTION OF FRENCH LINE STEAMSHIP LA PROVENCE.

All of the hull is of Siemens-Martin steel, but while the bottom is of soft steel with a tensile strength of 44 to 50 kilograms per square millimeter (28 to 32 tons per square inch), the upper parts are of semi-hard steel with a strength of 55 to 62 kilograms per square millimeter (35 to 39 tons per square inch). It has thus been possible, without necessarily going to the extreme limit of these figures, to diminish the weight of scantlings, and obtain a saving of about 350 tons in the weight of the hull. Compared with the total displacement, this is an insignificant figure, but when it is compared with the amount of weight available for passengers, etc., it is seen that it constitutes nearly 40 percent of that total.

The central portion of the ship is provided with two bilge keels. The double bottom, divided into a number of independent water tight compartments, covers almost the entire length of the ship, and serves not only to give security in case of leakage, but also to contain water ballast. The ship is divided along the length into twenty-two compartments by twenty-one transverse water tight bulkheads. These bulkheads are pierced by sixteen water tight doors operating by hydraulic power and by hand, and designed on the Stone-Lloyd system. This system of hydraulic maneuvering permits under ordinary circumstances a separate opening or closing of each door by the operation of a handle placed opposite the door. In case of danger or for the exercises which take place every twenty-four hours, the captain may from his bridge close all the water tight doors in the ship. He may in making the reverse maneuver reopen all those to which the manipulator was previously set at the "open" position. A loud bell always precedes this closing from the bridge. If, in spite of this notice, any one is locked into a compartment, he may, by operating the proper handle, open the door, which closes again after his escape. The water necessary for operating the doors is maintained in two accumulators under a pressure of 36 kilograms per square centimeter (510 pounds per square inch). It is kept at this pressure by a Weir pump, which is always in operation when the pressure is below the predetermined figure.

THE FIRST CABIN SMOKING ROOM.



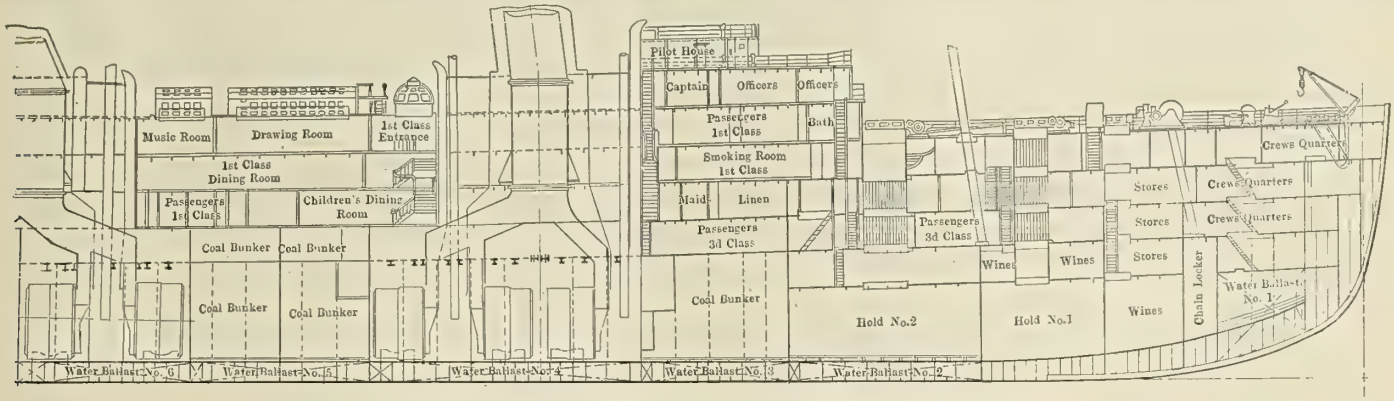
ORNAMENTAL RAILING, FIRST CABIN ENTRANCE.

The main engines are two in number, each of 15,000 horsepower, and are supplied with steam by twenty-one boilers. The lightening of the boilers is due to the use of semi-hard steel. The boilers employ forced draft by means of hot air blown into the ash pit. For the engines there has been adopted a rapid rotation, while materials of a considerable strength have been used for the moving parts and certain of the fixed portions. Nickel steel is used to some extent in place of soft steel for the shafts, and cast steel in place of cast iron for the bedplates of the engine. The twenty-one boilers are of the cylindrical marine type with return tubes, and are all single-ended, with four furnaces. They are distributed in four fire rooms, of which three

*Pages 206, May, 1905; 315, August, 1905; and 221, June, 1906.

contain each six boilers, and the foremost fire room three only. A single funnel serves in each case two groups. These funnels are elliptical in section with a major axis of 4.71 meters (15 feet 5 inches) and a minor axis of 3.92 meters (12 feet 10 inches,) while the height above the grates is 30 meters (98 feet

The boilers operate with forced draft by means of air blown into the ash pits, which are hermetically closed, while a certain proportion is led in above the fire. This system has the advantage of leaving the fire room in direct communication with free air, instead of necessitating its being sealed. In this way

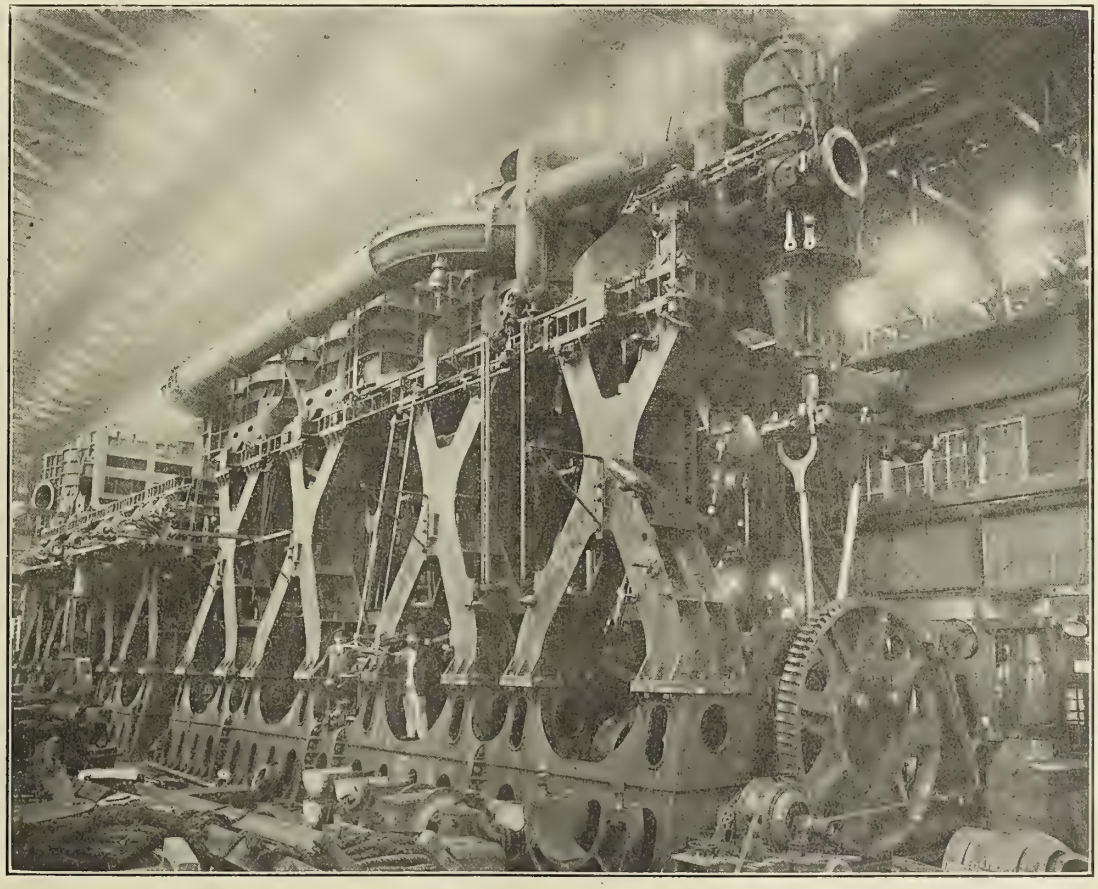


SHOWING THE GENERAL ARRANGEMENT OF THE MACHINERY AND ACCOMMODATIONS.

5 inches). The length of the boilers is 3.3 meters (10 feet 10 inches), and the diameter 5.2 meters (17 feet) for the after boilers, while the diameter of the forward boilers is 4.9 meters (16 feet). The furnaces are of the Deighton corrugated type, the total grate surface being 146 square meters (1,570 square

the designers avoided submitting the stokers to a largely increased temperature.

The air necessary for combustion is furnished by fourteen ventilators, two for each three boilers. These ventilators draw the air from out-of-doors and discharge it into special com-



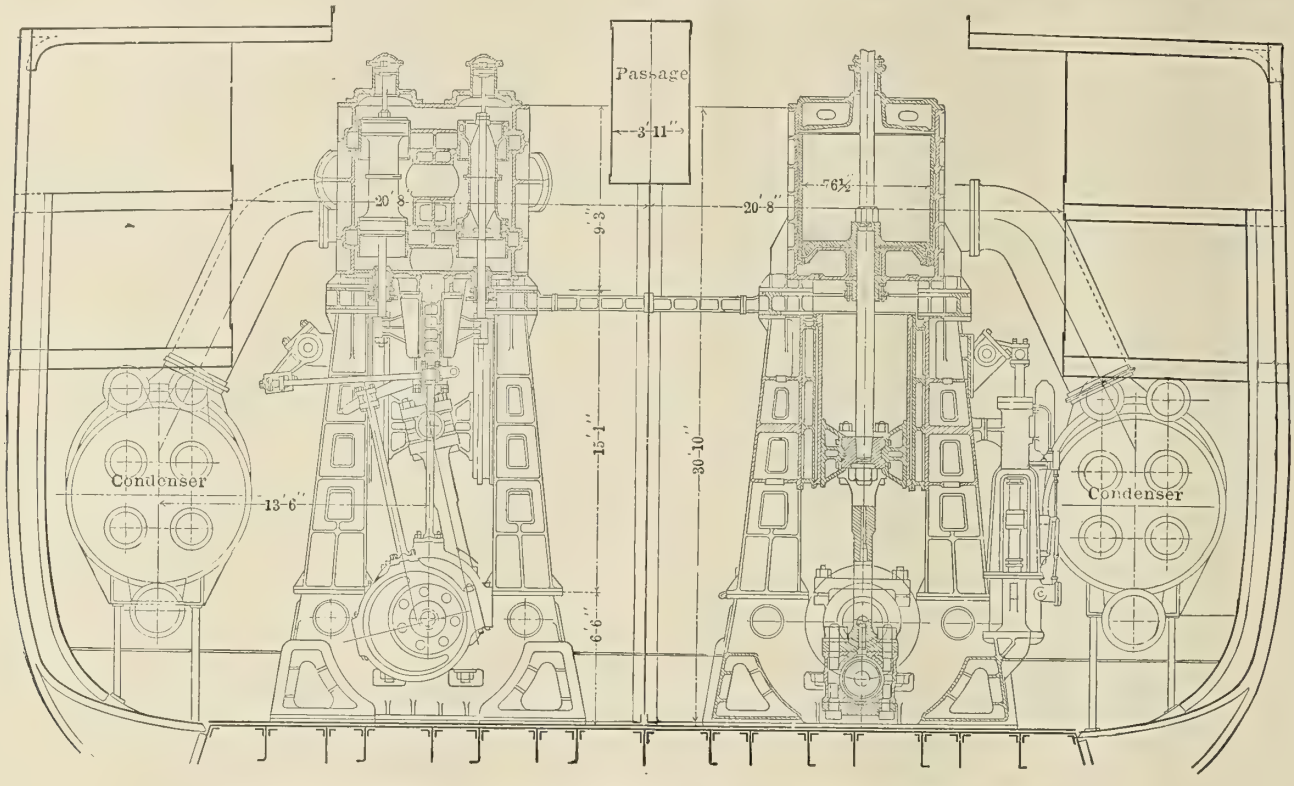
THE MAMMOTH ENGINES OF FRENCH LINER LA PROVENCE, AS ERECTED IN THE SHOP.

feet), and the heating surface 5,420 square meters (58,172 square feet). The ratio is 37 to 1. The total water volume is 600 cubic meters. The safety valves are set at 14 kilograms per square centimeter (198 pounds per square inch), which is only slightly above the pressure at which steam enters the high-pressure cylinders. For auxiliary machinery this pressure is somewhat reduced by special expansion valves, but in general the engines operate at boiler pressure.

partments containing a bundle of tubes traversed by the gases of combustion, which here give up a part of their heat. The air is, therefore, hot when it enters the furnaces, and combustion takes place under the best possible conditions. Thanks to this arrangement, the engines have been able to develop on trial more than 200 horsepower per square meter of grate (18.6 horsepower per square foot), with ample steam furnished by the boilers. In addition to the main boilers, there are on board two

boilers which are used only in harbor, when the larger units are extinguished for examination or any repairs which they may need.

heaters, in which it is heated by the exhaust steam from the auxiliary machinery. In addition to this, ventilators are interposed in the feed pipes of the pumps, operating by gravity.



TWO SECTIONS THROUGH ENGINE ROOMS, SHOWING GENERAL POSITION OF PROPELLING ENGINES.

The two main engines are identical in design, and are separated from each other by a water-tight bulkhead in the axial plane of the ship. They are of the four-cylinder triple expansion type, with the high-pressure cylinder forward and two low-pressure cylinders aft. The cylinder diameters are respectively 1.2, 1.94 and 2.242 meters (47¼, 76½ and 95¾ inches), with a common stroke of 1.7 meters (67 inches). The number of revolutions per minute is 90, corresponding with a piston speed of 4.54 meters per second (894 feet per minute). The valves of the high-pressure and intermediate-pressure cylinders are of the piston type, while those of the low-pressure cylinders are balanced slide valves. The surface condensers have each a cooling area of 1,652 square meters (17,750 square feet, or 1.184 square feet per horsepower). Before being again fed to the boilers, the water leaving these condensers passes through re-

The circulation of water in the condensers is made by means of centrifugal pumps operated by special motors. The air pumps and the feed pumps are independent, and of the Weir system. Each main engine is provided with two by-pass valves which permits sending the steam into the intermediate or low-pressure cylinder. They possess both a steam and a hydraulic reversing engine, the latter serving also as a check to prevent increase of speed of the shaft. The steam pipes are so disposed that in case of accident it would be possible to cut out the cylinder affected, and operate with the other three. The total length of the shafts is 66.7 meters (219 feet). They are all of nickel steel, hollow, tempered and annealed. The thrust shaft operates against a system of horseshoe collars, thirteen in number.

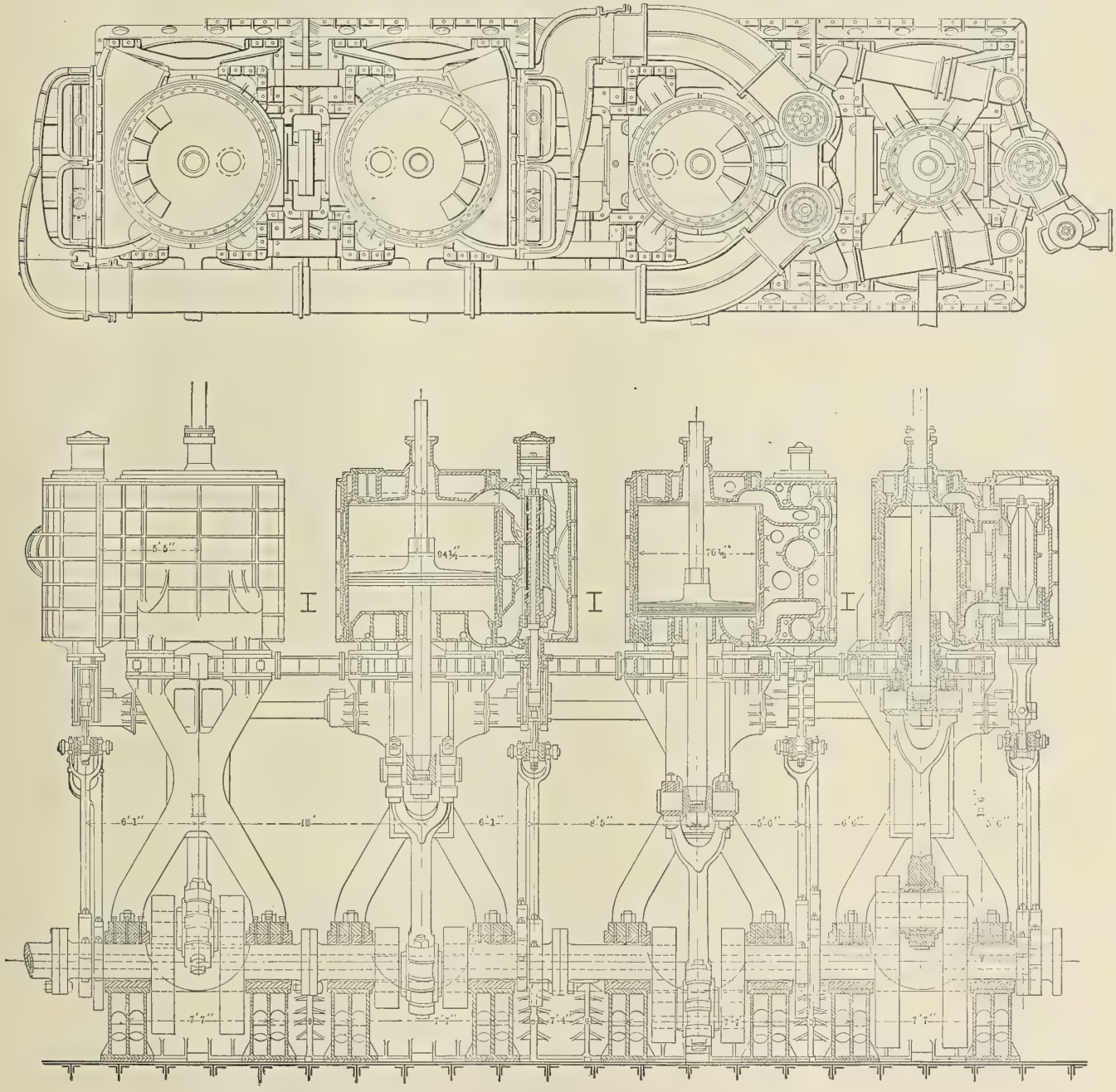
The two screws have each four blades, the total diameter being

UPPER PLATFORM IN THE ENGINE ROOM.

SHELTERED CAFÉ ON UPPER DECK.

A CORNER OF THE WRITING AND MUSIC ROOM.

DRAWING ROOM FOR FIRST CABIN PASSENGERS.



LONGITUDINAL SECTION AND PLAN VIEW OF PORT ENGINE ON FRENCH LINE STEAMER LA PROVENCE.

6.5 meters (20 feet 4 inches). The entering pitch is 8.4 meters (27 feet 6 inches), and final pitch 9.2 (30 feet 2 inches), giving a mean pitch of about 8.8 meters (28 feet 10 inches), and a pitch ratio of 1.35. The blades are of manganese bronze, with a tensile strength of 50 kilograms per square millimeter (32 tons per square inch), and elongation of 20 percent.

All the pumps are independent and operated by separate motors. The bilge pumps, two in number, have a capacity of 200 cubic meters (205 tons) per hour, and may by means of the piping system serve all the compartments in the ship. The freeing of the different main compartments of the ship is assured by five steam pumps with a capacity of 400 tons per hour each, and by six ejectors. The fire apparatus connects with the pumps by means of water pipes continually under pressure and is completed by six portable extinguishers.

E.O.

COLD STORAGE ON BOARD SHIP.

PART III.

BY SYDNEY F. WALKER, M. I. E. E.

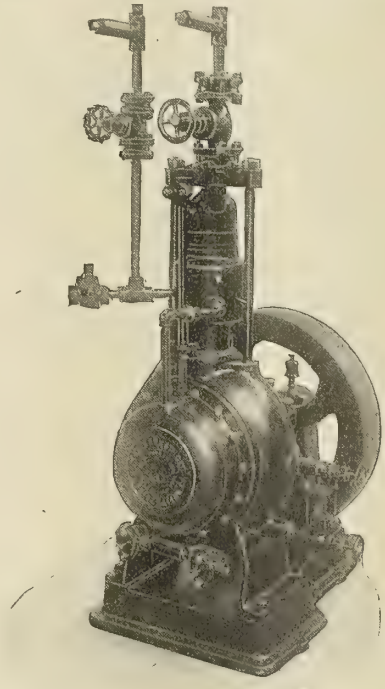
COOLING THE CHAMBER BY COOLING THE AIR.

This is the more frequent method adopted where fruit is carried, and it is the method that is coming more and more into vogue on shore, wherever it can be arranged. It enables the engineer to have a greater command over his work. But before describing the arrangements for this, another important matter, the ventilation of cold chambers, a matter leading directly to the process of cooling the air entering the chamber, should be considered. The proper ventilation of cold chambers is a very troublesome problem, and it is the troubles encountered in connection with this which, the writer believes, have led very largely to development in the direction of cooling the air itself.

In all cold chambers in which produce is stored a certain quantity of carbonic acid gas is formed, and other gases are also given off, which are more or less deleterious to the produce, and should therefore be kept at as low a percentage as possible. But the air which is laden with these gases can be got rid of only by allowing other air to enter and take its place, while the cleansing action that is advisable—the action of air in the process of ventilation is very similar to that of water in the ordinary processes of cleansing—demands that the fresh air shall be allowed to penetrate to every part of the chamber, and to reach every surface of the produce. But if outside air is admitted, it is usually at a higher temperature than that inside the chamber—there are exceptions which will be noted—and the incoming air brings heat with it. This may not be a serious matter, where it is known and provided for. Every time the door of the chamber is opened, to put in or take out produce, or for the entrance or exit of the attendant, the same thing happens, to an extent depending upon the construction of the doors and the care of the attendant.

In many cases no other provision is made for ventilation, but the best practice provides for its being carried out in a thoroughly scientific manner, and in such a manner as to assist the convection currents that are of so much use in distributing the cooling influence of the brine or expansion grid. Wherever the grid is placed, it will be understood, the air in its immediate neighborhood will feel the effect first, and this, becoming heavier as it cools, will tend to fall, allowing the lighter air to take its place. In some cases the convection currents so set up are hardly sufficient to distribute the cooling effect of the pipes to the produce efficiently, and this leads to a larger expenditure of coal and accessories. Where the grid is placed on the side of the chamber, for instance, the convection currents are sometimes very sluggish. The ventilation and the convection currents are assisted by fans, placed in any convenient position, driven by any convenient source of power, usually electric motors. The fans are arranged either to suck the air out of the chamber, an inlet being provided in another part, at a distance from the outlet, or to force the air into the chamber, an outlet being provided at the other end. The outlet should be a little above the floor line, in the great majority of cases, as the carbonic acid gas is heavier than air, while the inlet should be near the ceiling, at the opposite end. Fans should be arranged to assist the circulation of the air in the chamber, apart from the outside circulation.

The actual arrangement will vary with each case, and the engineer in charge will have to be guided by the condition of the cold rooms. In some cases the fan may be kept running continually to assist the convection currents within the chamber, there being no ingress of air to the chamber except at certain fixed times and for certain limited periods, and the entrance of the outside air being controlled by valves, opened from the outside. In a few cases it is possible to allow a small current of air to pass through the chamber all the time, remembering that it



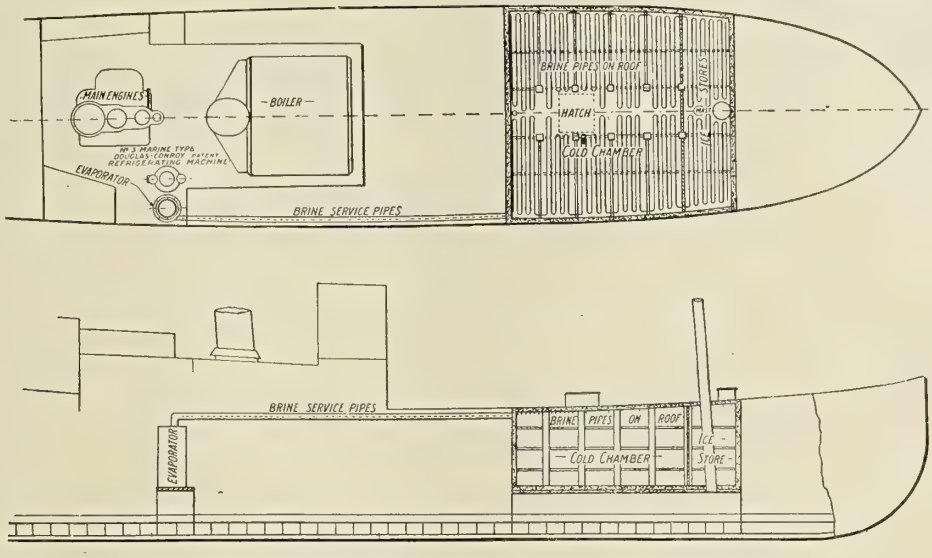
BRUNSWICK ONE-TON COMPRESSOR.

brings heat with it, and that the heat so brought must be abstracted, and further that it will be in proportion to the difference in temperature between the air from which the supply is taken and that of the chamber. The incoming air will bring moisture, which again must be abstracted, and this means the further abstraction of heat.

The quantity of heat brought in by the incoming air is found by multiplying the quantity of air passing in by the difference in temperature between it and the air of the chamber, and by the specific heat of air. We may take the specific heat of air as 0.2, it being neither at constant volume, nor at constant pressure. The weight of a cubic foot of dry air at 60 degrees is approximately 0.08 pound, so that there are 12.5 cubic feet of air in one pound, and one heat unit will, therefore, raise the temperature of 62.5 cubic feet of air one degree F. Conversely, air which is at a temperature of 60 degrees F., entering a cold chamber in which the temperature is say 10 degrees, will bring 50 heat units with every 62.5 cubic feet, or one heat unit with every 1.25 cubic feet, and with a chamber of 10,000 cubic feet capacity it would require the services of a machine capable of producing a ton of refrigeration in twenty-four hours, to deal with this in one hour, or a proportionately larger machine if it had to be dealt with in a shorter time; and this does not take any account of the moisture brought in. The question whether

this extra work shall be taken is one for consideration on the lines of the balance sheet. On one side should be put the deterioration of the produce, if any, that will take place if the store is not ventilated, and on the other the cost of the additional work involved in the removal of the additional heat.

Another important point must not be last sight of—the effect of the increased temperature upon the produce—but again this is a matter for careful regulation. The figures required are: how much air comes in, how much heat it brings with it, and how quickly the heat must be removed. This enables the work required to be calculated.



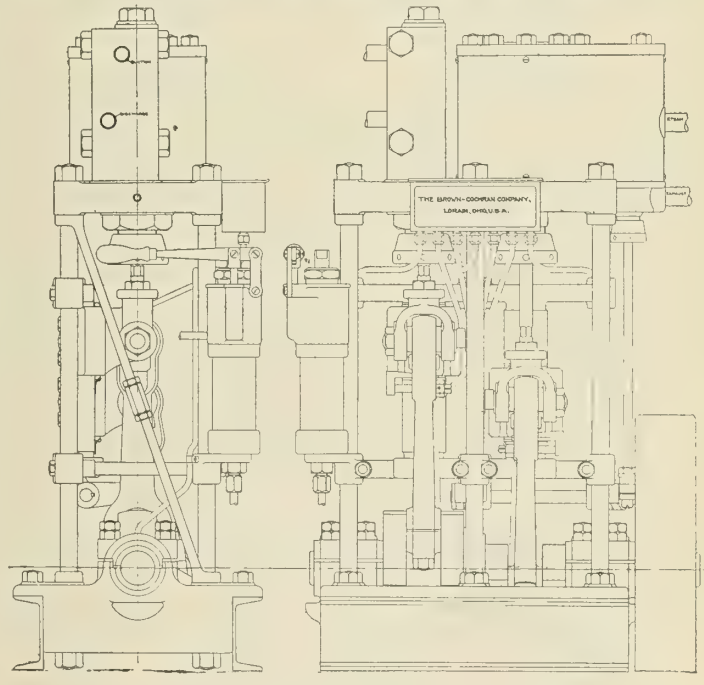
DOUGLAS MARINE INSTALLATION, SHOWING APPLICATION TO TRAWLER.

COOLING THE AIR ENTERING COLD CHAMBERS.

There are really two parts to the problem involved in cooling a chamber by cooling the air which enters it. There is the removal of the heat of the air itself, in order to reduce it to the temperature at which the air in the chamber is to be held; and there is the removal of the moisture held in suspension in the air. Both objects are accomplished at one operation, and both involve the abstraction of a certain number of heat units. Atmospheric air always holds moisture in suspension, the quantity held depending upon the temperature, and increasing very rapidly as the temperature increases. But the moisture in suspension is in the condition of vapor, and it can assume that condition only by absorbing a certain quantity of heat, from 900 to 1,000 units for every pound of water vaporized. The method of cooling wine by wrapping a wet towel around the bottle and putting it in the sun is well known; while the case of a man's wet clothes drying on his back and giving him a cold, will perhaps be more familiar. In both cases the heat necessary for evaporation is taken largely from the object upon which the damp fabrics are placed. In order, therefore, that the vapor held by the air shall be deposited, the latent heat of evaporation must be abstracted from it. The mere fact of cooling a certain quantity of air leads to the air's seeking to get rid of a portion of its moisture, and its deposition will lead to a rise of its temperature, owing to the delivery of heat by the vapor.

There is another factor in the problem of the deposit of the watery vapor from the air. The question arises, when will the vapor be deposited, and why? The capacity of air for absorbing the vapor of water varies, as shown in the accompanying curve. But the air is very rarely saturated with vapor, that is, it very rarely carries the full quantity of which it is capable, at any given temperature. In damp climates, in the winter months, it may carry as much as 85 or 90 percent of the quantity it would carry if saturated; while in dry climates, from 50 to 65 percent only will be carried.

Evaporation is constantly going on at all temperatures, from the surface of any liquid exposed to the air, and from any objects, such as dress fabrics, wood, etc., in which liquids are held. So the air above and resting upon the surface of a liquid carries a certain quantity of vapor. This exerts a certain pressure upon the surface of the liquid, apart from that due to the weight of the air itself, while the vapor which is being given off from the surface of the liquid also exerts a certain pressure upon the vapor already in the atmosphere above. The pressure of the vapor coming away from the liquid depends upon the temperature of the liquid, while the pressure of the vapor in the air above depends upon the temperature of the air, and the percentage of possible vapor carried. If the air and liquid are at the same temperature, and the air is saturated with vapor, no evaporation can take place, as the pressure of the vapor already in the



BROWN-COCHRAN CARBONIC ANHYDRIDE COMPRESSOR.

atmosphere, and of that issuing from the liquid, are equal. But where, as is nearly always the case, the air is not saturated, evaporation will go on until the pressures of the two vapors are equal. The converse of the above is also true. Where there is

a difference between the pressure of the vapor in the atmosphere and that of the vapor rising from some body with which it is in contact; in favor of the atmospheric vapor, the vapor will be deposited from the atmosphere, provided that it can deliver up its heat of vaporization to the surrounding objects.

Bearing in mind the fact that the capacity of air for carrying vapor rises rapidly with the temperature, it follows that any lowering of the temperature of the air immediately tends to increase the percentage of saturation, and to increase the vapor pressure, and its tendency to deposit. The vapor pressure is obtained by first finding the percentage of saturation of the air, by the wet and dry bulb thermometer; and then consulting a table that has been compiled from observation. From another table, also compiled from observation, the vapor pressure at saturation at different temperatures is obtained, the actual pressure of the vapor in the air, at the temperature to which it is reduced, being determined from these two tables, and the thermometer readings. The vapor pressure of the ice or snow on the brine or expansion grids used in cooling the air, as explained below, is also known, from its temperature—vapor is coming away from even ice and snow, if its vapor pressure exceeds that of the air in contact with it—and it will follow that when the vapor pressure of the air, at its reduced temperature, is greater than that of the vapor of the ice or snow, or the cooling brine, moisture will be deposited from the air upon the grid, or in the brine, the density of the brine solution being lowered in consequence.

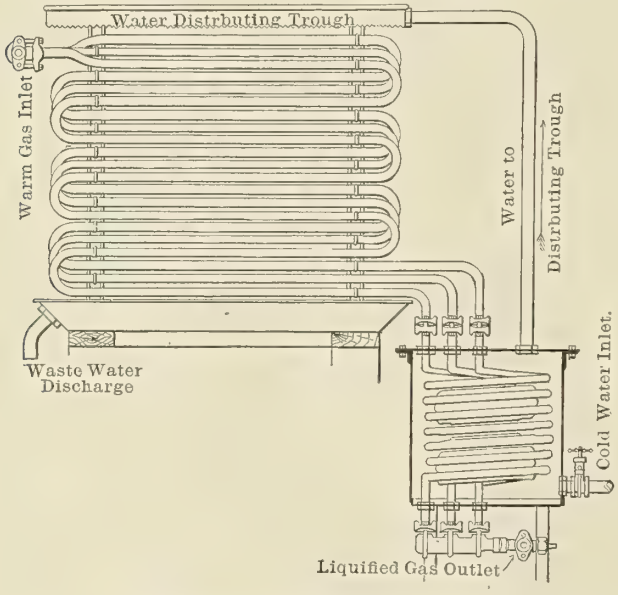


DIAGRAM OF WEST EVAPORATIVE CONDENSER.

The quantity of water per cubic foot of dry air, when the air is saturated, varies from 0.000079 pound at 0 degrees F., up to 0.0368 pound at 212 degrees F., and at ordinary barometric pressure. With air that is to be cooled from 70 to 15 degrees F., and deprived of its moisture, it is necessary to first abstract the heat carried by the air itself, and then to abstract that carried as latent heat by the vapor. The two operations go on together, but the calculation is made separately. Thus the air has to be cooled 55 degrees, so that each pound of air must be deprived of 11 units, and each cubic foot of 0.88 unit, or 880 units per 1,000 cubic feet. If we take the vapor saturation of the air as 72 percent, we find that the air will contain 0.0009 pound per cubic foot, or 0.9 pound per 1,000 cubic feet, and this will mean, approximately, that 900 heat units have to be abstracted, in order that the vapor may assume the liquid condition and be deposited. If it is formed into ice or snow, as usually happens, when the moisture is deposited on the grid, the latent heat of the liquid must also be abstracted, a further 128 units, or a total of 1,908 units per 1,000 cubic feet of the air to be cooled.

The above figures are given to enable marine engineers to see how the calculations are made, and how important is the question of the vapor in the air. The latter is changing from hour to hour, especially when a ship is changing her latitude somewhat rapidly, and therefore any calculations that are made should be on the basis of the worst conditions to be met. If the air is not properly dried, some vapor will pass into the cold chamber, and will there be deposited upon the cold surfaces of the produce. Hence sufficient refrigerating power should be provided to extract the largest quantity of moisture that will be encountered.

METHODS OF COOLING THE AIR.

There are three methods employed, though only two of them are applicable to the general run of ship work. The air may be caused to pass over the surface of brine that has been cooled to a low temperature; it may be caused to pass over the surface of a grid in which either brine or the refrigerant is circulating; or again, may be cooled by compression and expansion.

The first method is the most economical, and is largely employed in cold stores on shore. The usual arrangement includes cooling the brine in a tank through which the refrigerant is circulating. It is then carried to a point where it can conveniently be interposed in the path of the air. At this point a battery of galvanized corrugated iron plates is fixed, the plates being hung vertically. The brine is made to trickle down over the plates into a trough below, from which it is pumped back to the evaporating brine tank. The air, which has done its work in the cold store, or which is brought fresh from the outer atmosphere, is forced between the plates of the battery by a fan. In passing between them it is cooled, and its moisture and other substances that are not wanted are deposited in the brine, the air then passing on to the cold chambers. With this arrangement, the brine is diluted by the water taken from the air, and has to be subjected after a time to a process of partial evaporation; it is boiled in a pan having a steam jacket until its density is restored to the proper figure.

In the next plan a grid of pipes, somewhat similar to those that have been described for cooling the cold chambers themselves, is placed in any convenient position where the air can be forced through it on its way to the chamber. The air with ship work is taken usually from the atmosphere, in the first instance, by means of a shaft leading from the fan chamber to a sufficient height above the upper deck to insure its being free from stokehold odors, grease, etc. In many cases, however, the same air is used over and over again, being passed around through the fan and over the grid, after it has passed out of the chamber.

The fan chamber leads directly to the cooling grid, and is also connected to the exit ducts of the cold chamber, the engineer being able to arrange the air as he finds best, being guided in that by the condition of the produce. He also has it in his power to work directly from the atmosphere, without cooling the air at all, where the conditions warrant his doing so, the air being simply taken in from the atmosphere and expelled to the atmosphere again. The cooling grid is made in sections, each section being connected to a header, where valves are arranged, so that any section can be put into service or cut out at will, and the refrigerant, or the brine, circulates through the grid according to the requirements of the chamber. In hot climates the engineer may have perhaps all the sections in service, while as the ship passes into colder latitudes he will take off one section after another, and possibly in cold weather depend entirely upon the atmosphere for parts of the day.

As mentioned above, the moisture present in the atmosphere has a very important bearing upon the question, whether the air shall be used over and over again, or whether fresh air shall be admitted. When it is used in a closed circuit the quantity of moisture present and the temperature of the air coming from the chamber are known, and therefore the quantity of cooling the latter requires; but when fresh air is admitted from the outside, the engineer does not know, without testing, what its hygroscopic condition is, and how much cold will be required.

Hence it is simpler to use the same air continuously. The moisture that is present in the air condenses on the outside of the pipes of the grid, and is then frozen, the frozen skin acting very much as the trickling brine does with the battery of plates. When the machine is stopped, the mass of ice and snow melts and is collected in a trough provided for it under the grid, and disposed of in the usual way.

COOLING THE AIR BY COMPRESSION AND EXPANSION.

This method was employed a good deal in the early days of cold storage, especially for ship work, and it has a great deal to recommend it, even now, for small work, such as the cold store for ship's provisions in a small ship. For large work it is not so economical, and the quantity of air required is so much larger, as is also the apparatus to deal with it, that it has gradually fallen into disuse, except for special cases. On the compressed air system, air is taken from the atmosphere in the first instance, drawn into a cylinder which performs the office of pump and compressor, and is there compressed by the action of a piston. In the act of compression heat is generated in the air. Now, it would be fatal to the utility of the air as a cooling agent if any moisture were present. Hence, after passing through the compressor, the hot air is passed through a cooling and drying apparatus, where the heat which has been generated by compression is taken out, and any moisture it carried is deposited.

There are several forms of cooling apparatus for air, the principle being the same as already described for cooling the air going into the cold chamber, but there is no brine grid available. One plan is to pass the air through a cylinder containing a number of small glass balls, like marbles, over which a thin stream of water trickles. The air enters the cylinder at the bottom, and the water trickles down from the top. The air is gradually cooled as it passes upwards, and as it cools deposits the moisture it carries, so that it issues at the top of the cylinder partially cooled, and fairly dry. The principal cooling is performed in the next operation, in a second cylinder, whose piston rod is connected through its own crank to the same crank shaft as that of the compressor piston. This is called the expansion cylinder, and performs the same office as the expansion coils where a refrigerant is employed. The air which has been cooled and dried is allowed to pass into the expansion cylinder behind the piston, which it works, expanding in the process. The cranks of the two pistons are set at right angles to each other, so that the work which the expanding air performs on the expansion piston assists the compressor piston. In expanding, the air is cooled, and as air or any other gas can expand only if it has the space, and can obtain the necessary quantity of heat to enable it to do so, it abstracts heat from surrounding bodies and becomes itself lowered in temperature. The compression stroke of the compressor coincides with the expansion stroke of the expansion cylinder, and at the suction stroke of the compressor, the piston of the expansion cylinder forces the cooled air out to the cold chamber, or wherever it is to go.

The cooled air is employed only to dilute the air of the cold chamber, so that the temperature of the latter is carried at whatever figure may be desired. The calculation for the quantity of air to be cooled, and the temperature at which it shall be forced into the cold chamber, is simple. Each cubic foot of the cold air will absorb a certain number of heat units while its temperature is being raised to that of the air in the cold chamber, the temperature of the latter being lowered in the process; but it must be remembered that as the entering air rises in temperature, it also increases in volume, and the cooling effect of a cubic foot of air, at each succeeding temperature, becomes less and less.

In practice the average is taken, through the range of temperature. The air after expansion may be at as low a temperature as —85 degrees F. Some makers of compressed air refrigerating apparatus claim to reduce it to —100 degrees F. Taking it at —85 degrees F., and taking the mean between this and the temperature at which the cold chamber is to be held, say 15 degrees F., or a difference of 50 degrees, every 100 cubic feet will absorb 80 heat units.

(To be continued.)

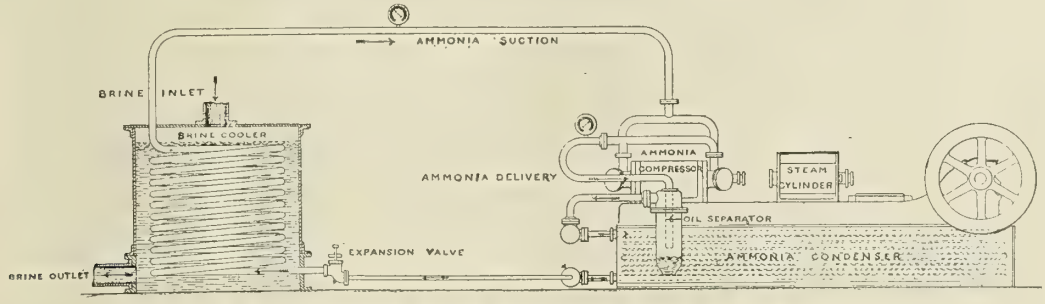


DIAGRAM OF HASLAM AMMONIA OUTFIT, SHOWING THE SEVERAL PARTS OF THE APPARATUS.

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports under date of July 11, 1906, the following percentage of completion of vessels building for the United States Navy:

			June 1	July 1
BATTLESHIPS.				
Nebraska	19 knots.	Moran Brothers Co.	94.	95.16
Georgia	19 "	Bath Iron Works	96.7	97.47
Connecticut	18 "	Navy Yard, New York, N. Y.	97.41	97.41
Vermont	18 "	Fore River Shipbuilding Co.	85.	88.5
Kansas	18 "	New York Shipbuilding Co.	82.2	85.2
Minnesota	18 "	Newport News Co.	89.76	91.44
Mississippi	17 "	Wm. Cramp & Sons	57.67	59.86
Idaho	17 "	Wm. Cramp & Sons	55.73	58.07
New Hampshire	18 "	New York Shipbuilding Co.	45.7	48.
ARMORED CRUISERS.				
California	22 knots.	Union Iron Works	93.3	94.
South Dakota	22 "	Union Iron Works	91.1	91.8
Tennessee	22 "	Wm. Cramp & Sons	98.97	99.75
Washington	22 "	New York Shipbuilding Co.	98.2	99.
North Carolina	22 "	Newport News Co.	46.35	50.5
Montana	22 "	Newport News Co.	41.32	44.72
SEMI-ARMORED CRUISERS.				
St. Louis	22 knots.	Neafie & Levy Co.	96.78	98.77
Milwaukee	22 "	Union Iron Works	95.2	96.1
SCOUT CRUISERS.				
Chester	24 knots.	Bath Iron Works	32.34	36.88
Birmingham	24 "	Fore River Shipbuilding Co.	34.7	38.4
Salem	24 "	Fore River Shipbuilding Co.	35.7	39.3
SUBMARINE TORPEDO BOATS.				
Submarine No. 9		Fore River Shipbuilding Co.	72.5	75.9
" " 10		Fore River Shipbuilding Co.	57 6	62.
" " 11		Fore River Shipbuilding Co.	64.1	72.3
" " 12		Fore River Shipbuilding Co.	56.9	59.

Personal.

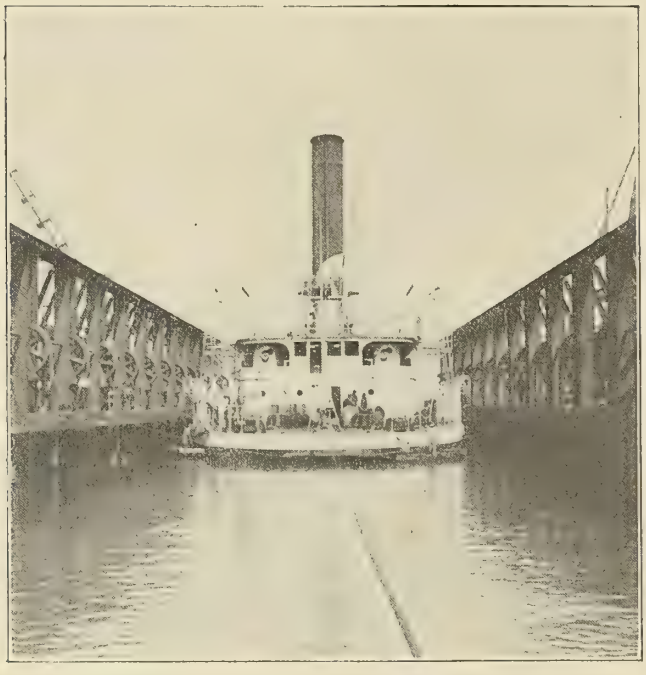
James Nelson Alexander has been transferred from the office of the Inspector of Machinery of the United States navy at the Neafie & Levy Shipbuilding Company, to the same office at the shops of the New York Shipbuilding Company, Camden, N. J.

SAN FRANCISCO HARBOR.*

BY CHARLES GREEN.

A thousand causes have tended to center population around San Francisco Bay, producing the phenomenal growth of San Francisco, the business center of the Pacific coast region. This is not because of any temporary advantage, but in consequence of its inherent advantage of location. Nature never designed a more beautiful environment. Located on a commodious bay forming one of the finest landlocked harbors in the world, with a depth of from fifty to three hundred feet, and rivaling Naples in picturesque scenery, San Francisco undoubtedly, by natural advantage and impetus, will continue to retain its preeminence on the coast.

GENERAL VIEW OF THE UNION IRON WORKS, FROM THE BAY.



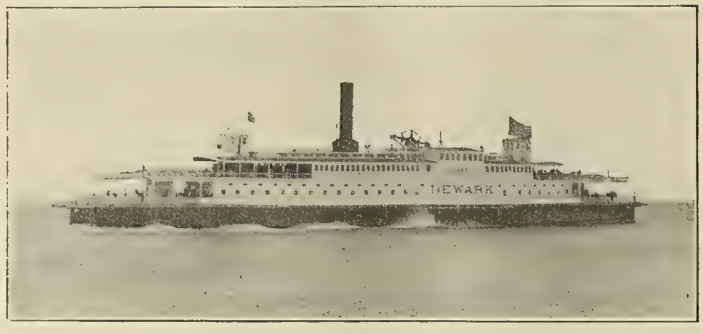
MONITOR WYOMING ENTERING HYDRAULIC DOCK.

One chief advantage is the cheap and rapid transportation facilities, relieving the congestion of the centers of population and carrying the people off into the rural districts across the bay; thus giving to the workingmen an encouragement to work in such a city, and to live where one or more acres of ground can afford the family all the pleasures and healthfulness of country life, with the economies which result from the high cultivation of small pieces of land for household use.

This can be especially said of Oakland, Berkeley, Alameda and Sausalito, and the surrounding territory, where thousands of commuters ferry to and from San Francisco daily. Judging from the growth of these towns in the past few years, it appears probable that there will soon be a continuous city over twelve miles long, and extending back to the foot hills.

The distance between the water fronts of San Francisco and Oakland is about six miles, but the ferryage has been reduced to four miles by building long moles and wharves out into the bay. The time occupied in crossing is about seventeen minutes. The tourist, on arriving at Oakland, the terminus of the Southern Pacific Company, is given an excellent view of San Francisco and its harbor, while crossing on the largest ferryboats in the world. These boats, the *Oakland, Berkeley* and *Newark,* were especially designed by the Southern Pacific Company for this route, and have a seating capacity of 2,000 people each. The *Oakland* and *Newark* are of the side wheel type, driven by powerful beam engines, while the *Berkeley* is of the double screw type, with one screw on each end, working on a continuous shaft, and the motive power consisting of an inverted triple expansion engine. Both types of boats burn oil for fuel, this being almost universally used on the boats in the harbor.

The boats pass close to Goat Island, which reaches up some four hundred feet above the water, and on which is located the naval training school. From this point the city makes an impressive appearance, especially at night, when ablaze with lines of lights climbing the hills. The harbor is also in full view, with vessels from all parts of the world. Nearly every type of steam craft is represented, among others being stern wheels of the Mississippi river type, lumber schooners, army transports, whalers, and full rigged ships.



ONE OF THE LARGEST PASSENGER FERRYBOATS AFLOAT.

The use of the steam schooner is confined exclusively to the coast of California, usually on short runs of two hundred to three hundred miles. These schooners are fitted with both sail

*Written before April 18, 1906.

and steam as motive power, a typical length being 150 feet, beam 34 feet, and depth 17 feet. Many are fitted with triple expansion engines and water-tube boilers. The stern wheelers are used principally for duty on the shallow rivers, many of the largest ones plying between San Francisco, Sacramento and Stockton.

UNITED STATES BATTLESHIP OHIO ALONGSIDE WHARF AT UNION IRON WORKS.

THE OHIO IN THE BIG DRY DOCK AT HUNTER'S POINT.

In 1902 the Pacific Mail Steamship Company brought out two of the largest vessels ever built in the United States, the *Korea* and *Siberia*, of 11,276 tons. The *Mongolia* and *Manchuria*, which arrived two years later, have a gross tonnage of 13,639. Each of the latter is 615 feet 8 inches long, 65 feet beam, 51 feet 3 inches deep, and has a load draft of 33 feet 6 inches. There are four masts, five complete decks, ten watertight bulkheads, and bunkers capable of carrying 2,800 tons of coal. They are driven by bronze twin screws 18 feet 6 inches in diameter, operated by engines of the four-cylinder triple expansion type, developing 10,000 indicated horsepower.

PACIFIC MAIL STEAMSHIP MONGOLIA, 13,639 TONS, IN DRY DOCK AT HUNTER'S POINT.

The Occidental and Oriental Steamship Company operates a fine line of steamers, three of which are almost as large as the *Korea* and *Siberia*. The passenger accommodations and appointments on all these vessels are very beautiful, and the color schemes of woodwork, painting and draperies most pleasing, every detail being carefully studied and carried out.

OUTWARD BOUND.

The increasing commerce across the Pacific required these mammoth vessels, nearly all goods made in this country having found a market across the water. Under the guidance of far-sighted men, exports alone to the Orient have grown over 50 percent within a few years. As an immediate evidence of the practical results of this development, outgoing freight upon all lines of steamers shows a steadily growing volume and variety of commodities.

That the shipbuilding industry has been a prime factor in the building of San Francisco can be appreciated by considering the

UNITED STATES SUBMARINE BOAT IN THE BAY.

fact that the Union Iron Works, during the past seventeen years, has secured contracts for building twenty government vessels of every variety, of a total cost of over $28,000,000, and giving employment to an average of 3,500 men. These works, which are located within twenty minutes ride of the center of the city, are equipped with five building slips, and all the modern tools and appliances for building and repairing all types of vessels. The equipment includes a hydraulic dry dock capable of lifting a five-thousand-ton vessel, and sheer legs of 150 tons capacity. This plant has the reputation of turning out some of the finest work

of its kind in this country, manufacturing every detail involved in the construction of ships, including windlasses, steering engines and complete generating sets.

At present the United States cruisers *California, South Dakota* and *Milwaukee* are nearing completion; and the hulls being erected for the new 500-foot American Hawaiian Steamship Company's vessels. Besides the construction of vessels, this company makes a specialty of mining machinery, having equipped the largest mines on the coast.

VIEW OF PROTECTIVE DECK OF CRUISER MILWAUKEE, BUILT BY THE UNION IRON WORKS.

STEAMER COLUMBIA TIPPED OVER IN DRY DOCK.

Among the other shipyards are the plants of the Risdon Iron Works and the Fulton Iron Works, which also enjoy the reputation of building first class vessels for local trade. Along the harbor will also be seen many dry docks of the floating type. These docks are almost constantly in use, and a thriving business is done in this line. The largest docks are located at Hunter's Point, having lengths of 700 and 450 feet, respectively, and capable of docking the largest vessels. With these and many other industries, the docks of the different steamship and railroad lines, and the handsome ferry building with its seven slips, San Francisco harbor presents a scene of activity that well justifies the Golden Gate's being termed the front door to the Orient.

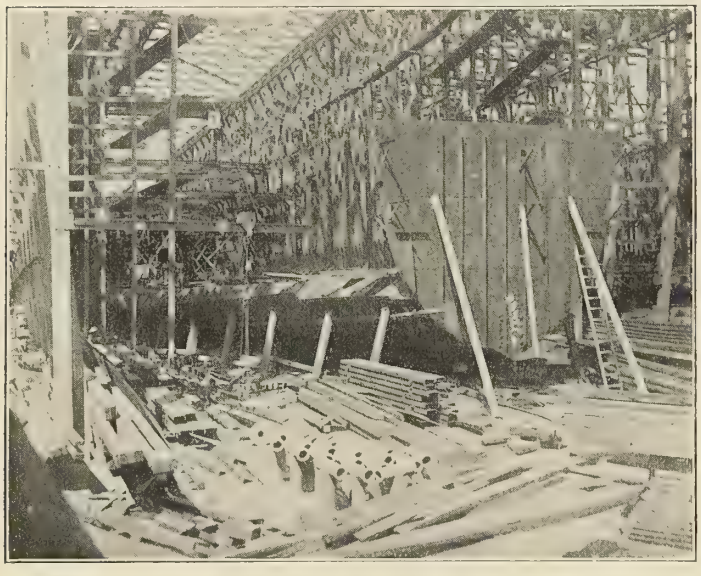
The above article was written before the terrible disaster which overwhelmed the city of San Francisco in April. As a general proposition, while a great deal of wharf property was seriously damaged by the earthquake, the damage to shipping was slight. In the yard of the Union Iron Works, two large steamers were under construction for the American-Hawaiian Steamship Company, and a third had been started. The two which were well under way were pitched forward and dropped from the keel blocks, being somewhat warped, but not seriously damaged. One of our photographs shows the condition of one

FERRYBOAT FRAMING THROWN ON BEAM ENDS.

of these steamers a few days after the earthquake, and gives little indication of trouble.

In dry dock in the same yard was the steamship *Columbia,* of the Oregon Navigation Company, the necessity for some slight repairs having accounted for her position. The shock damaged the bottom of the dock, and threw the *Columbia* over against the side walls, tilting her to an angle of about 45 degrees. In the meanwhile water rushed into the dock and quickly filled the ship. So far as a hasty survey indicated, the ship received no serious damage.

The *Columbia* is an iron steamer measuring 310 feet by 38 feet 4 inches by 22 feet 2 inches, and has gross and net tonnages of



THE AMERICAN-HAWAIIAN LINE STEAMER.

2,722 and 1,746 respectively. She was built in 1880 by Roach & Son, of Chester, Pa., and is fitted with a compound engine of 2,100 indicated horsepower. The cylinders measure 37 and 82 inches in diameter by 42 inches stroke. Steam is supplied by four cylindrical return tubular boilers with a diameter of 12 feet and a length of 11 feet 1 inch. The working pressure is 130 pounds per square inch, and the boilers are fitted for the use of liquid fuel.

The steamship *City of Puebla,* of the Pacific Coast Steamship Company, which was lying alongside the wharves waiting for repairs, was seriously damaged by being struck with a pair of steel shear legs, which toppled over on her from the pier. These crushed part of the upper works of the ship, and punched a hole in her port side at the water line. The injury has been repaired.

The *City of Puebla* is an iron steamer, built in 1881 by William Cramp & Sons, of Philadelphia, and measures 319 feet by 38 feet 6 inches by 26 feet 3 inches. Her gross and net tonnages are respectively 2,624 and 1,713. She is propelled by a compound engine with cylinders 43 and 86 inches in diameter and 60 inches stroke. Steam is supplied by four cylindrical return tubular boilers, 14 feet 10 inches in diameter and 13 feet 4 inches long, operating at a pressure of 115 pounds.

The Bureau of Navigation of the Department of Commerce and Labor reports the construction during July of 113 vessels amounting to 31,026 gross tons. This includes ten vessels propelled by steam and aggregating 26,662 tons, of which 4, amounting to 25,681 tons, were built on the Great Lakes. These four are all of upwards of 4,800 tons. The remaining 109 vessels have an aggregate of 5,345 tons, or an average of 49 tons each.

PNEUMATIC TOOLS AS APPLIED TO SHIP CONSTRUCTION AND THEIR ADVANTAGES TO SHIPBUILDERS AND ENGINEERS.*

BY CHARLES SCHOFIELD.

About three years ago the shipyard managers of the United States decided to ascertain whether pneumatic tools as applied to ship construction were a financial success or not, and what actual advantages accrued from their use. They appointed a committee, instructing them to make the necessary inquiries from the various shipbuilders of America, and report the result of their labors at the next meeting. The paper presented caused more discussion and diversity of opinion than any other topic during the whole session. The reports of the various shipbuilders as returned disclosed a most satisfactory state of affairs, and proved beyond a doubt that pneumatic tools as applied to ship construction were a known quantity and beyond the experimental stage. The information thus obtained was not only interesting but instructive to the members generally.

I will endeavor in my paper to explain the methods adopted in the American shipyards as to the application of pneumatic tools in ship construction, also the cost of same, and make a comparison with the British piece-work hand rates.

PNEUMATIC CHIPPING HAMMER.

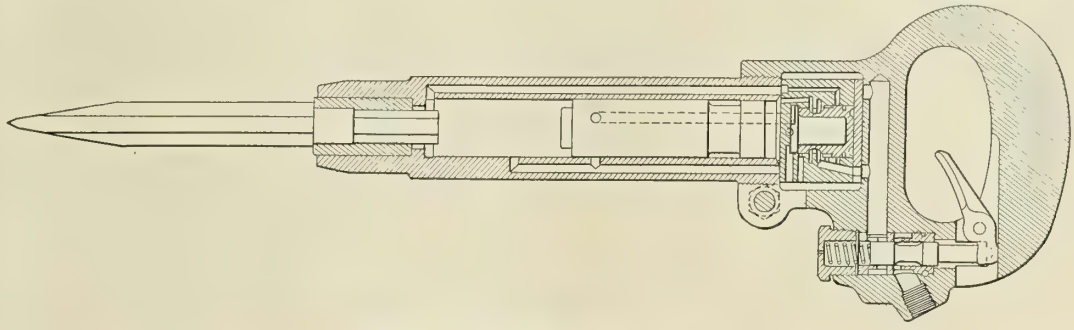
The first portable pneumatic tools introduced to shipbuilders were chipping hammers, Fig. 1. A pneumatic chipping hammer consists of a working cylinder, having attached to it a grasping handle, and inclosing a reciprocating piston and a valve box containing a reciprocating valve. In the lower part of the handle the air-inlet passage is situated, and is controlled by a piston throttle valve arranged therein, adapted to be operated by a pivoted finger lever. The air, after passing the valve, enters the transverse passage, which communicates with an annular groove situated immediately adjacent to the valve box. This groove serves to distribute the air to the various inlet ports and passages in the valve box. The valve box itself is in the form of a hollow cylindrical block bored out to two different diameters to receive the valve corresponding in shape. The valve box is provided with the necessary ports and passages to admit live air to and exhaust from the opposite ends of the cylinder, and for controlling the valve itself in coöperation with the piston. The valve contains no ports or passages, but has two grooves, one cut in the portion of small diameter, and one in that of large diameter. It will be seen that the valve, being made of two diameters, has two pressure surfaces or areas, against the smaller of which air constantly acts to press the valve in one direction; and against the larger area, air under pressure is intermittently admitted through the ports and passages in the valve box and cylinder, those in the cylinder being so controlled by the piston as to move the valve in the opposite direction against the constant live-air pressure on the smaller area. The piston is a solid cylindrical bolt having a groove in its periphery near one end for the purpose of placing in communication with each other the live-air passage, shown in dotted lines leading from the source of supply to the piston chamber, and another passage leading from the piston chamber to the larger area of the valve. The outer end of the cylinder is partly closed by means of an internal ring and the working tool's socket. When the working tool is inserted into the tool socket the closure of the end of the cylinder is thereby completed.

In the illustration the valve is in such position that the air is in contact directly with the piston so as to force it forward at high speed until it hits the tool end. When the portion of reduced diameter of the piston comes opposite to the end of the live-air passage, and puts this into communication with the passage leading back to the large area of the valve, the position of the valve is immediately reversed, whereby the live air passes round the groove in the portion of the valve of large diameter into the passage on the opposite side at the front of the piston,

*Read before the North East Coast Institution of Shipbuilders and Engineers, November 24, 1905.

forcing the same in a backward direction. The piston on its return stroke cuts off the supply of air from the larger area of the valve, and the latter returns to its initial position, admitting air behind the piston for the next stroke.

It was with fear and trembling that we, the shipyard managers, attended the several demonstrations prepared for our edification by the various pneumatic tool companies, as, of course, we were expected to try the tools; and sometimes we thought the piston was taking air at the wrong end on account of the excessive vibration, but this was eventually minimized by the makers adding a little more weight to the hammers. After we had got accustomed to handling the tools and had overcome, to some extent, our prejudice, it became evident to us that the pneumatic chipping hammer had some merit; inasmuch as it could do work in close quarters much better and in less than half the time the same work could be done by hand.



SECTION OF PNEUMATIC CHIPPING TOOL.

It was, however, months before we could get the men using pneumatic tools to admit that there was sufficient benefit derived from their use to warrant a reduction from the hand piece-work rate, and it was only by playing our cards diplomatically that we got our first reduction of 40 percent on all chipping and cutting, because, at this time, the men experienced great difficulty in chipping a plate edge to a bevel, or when dressing a shell butt, on account of the hammers having round bushings to take the shank of the chisel, whereby the man operating the tool had to twist the chisel as best he could without any assistance from the hammer. But all the up-to-date hammers of to-day have hexagon bushings, and the chisels have hexagon shanks to suit, so that the operator can twist the chisel to any desired angle by twisting the hammer, while a calking iron with a round shank can be used in the same hammer without the bushing being changed. The current piece-work rate for pneumatic chipping, solid cutting and calking in the United States is about 50 percent less than the piece-work hand rates of Great Britain; that is, taking the day-work rates of both countries as a basis. Another feature of the pneumatic calking hammer is that it calks the toe of the gunwale, waterway, tank margin and bulkhead bounding bars without their having been either planed or chipped. This allows the builder to order the said angles the same size as he would if they were not to be calked.

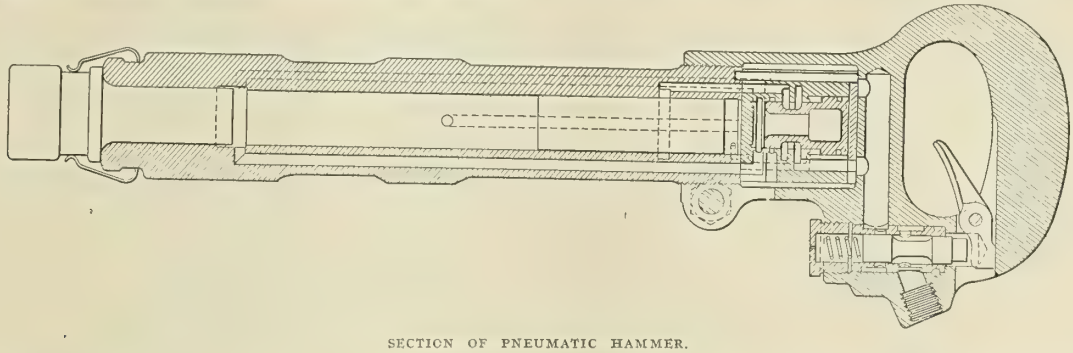
Pneumatic hammers are used extensively by engineers for dressing propeller blades, the palms of struts for vessels with twin screws, bed plates, cutting key ways, cleaning castings, etc., in fact, there is very little hand chipping done in the fitting shops of the American engine builders.

PNEUMATIC DRILLS.

When pneumatic drills were first introduced to shipbuilders they had to compete with electric drills of all sizes and weights; and during a four weeks' test at the works of William Cramp & Sons, of Philadelphia, the pneumatic drills proved their superiority. At the time of the test we were building three cruisers and two battleships, which had protective decks made up of two plates, each 1½ inches thick, connected by 1¼-inch rivets. It was on these plates we made the test, the average for the twenty-four days being as follows:

	Holes drilled.	
	Pneumatic.	Electric.
Air pressure on 12 days, being 90 pounds	248	100
" 9 " 84 "	232	100
" 3 " 76 "	208	100

The result was that we dispensed with twenty-six electric drills, and took 60 percent off the piece-work rate of drilling on this class of work; we also made a reduction of 60 percent on the price of holes drilled in the deck plating for deck planking, and took 50 percent off all other drilling on the ship, except odd work.



SECTION OF PNEUMATIC HAMMER.

Pneumatic drills are now used for every conceivable purpose by American shipbuilders, among others, cutting out side-light holes, ventilator and coal port-holes in the deck, boring stern-post gudgeons, wood backing for armor-plate bolts, tube cutting, tube expanding, tapping for stay bolts, screwing in stay bolts, and by using a speed reducing gear attached to the drill it is possible to tap up to 4 inches diameter, and to operate this combined machine only one man and a boy are required. In fact, the pneumatic drill is an indispensable factor in connection with speedy and economical ship construction in its various branches.

PNEUMATIC RIVETING.

Probably the hardest manual labor in all the various operations in building a ship is that of riveting. Combined with this is a certain amount of technical skill acquired only by an apprenticeship at the trade. A first-class riveter on inside work cannot properly drive shell rivets and *vice versa*, while the boiler riveter,

however good he may be at his own work, is of little use on any part of the ship's hull. In addition to this, the rapidly increasing size of ships, with the corresponding necessity for heavier plating, doublings, etc., requires the use of larger and longer rivets, which cannot properly fill the hole when driven by hand, however skilful or willing the men may be. For all these reasons combined, in the yard of the Cramp Company, of which I was the shipyard manager, some seven years ago a determined effort was begun and an extended series of experiments entered upon to develop pneumatic machinery capable of being operated by unskilled labor, by which all the rivets in the ship could be driven. This effort has been entirely successful, not only at Cramp's, but at all the leading shipyards in the States.

I recently sent to the four leading shipbuilders in America a letter asking them to cable me the approximate percentage of the entire number of rivets in the shell of a ship which they were now driving with pneumatic tools.

I received the following cablegrams in reply:

"Eighty-five to ninety."—James Wallace, Managing Director for the American Shipbuilding Company.

"Thirty shell, eighty hull."—Orcutt, President of the Newport News Shipbuilding Company.

"One hundred."—Wilson, General Manager, Marine Department, The Maryland Steel Company, Sparrow's Point.

"Ninety-nine."—Cramp's.

The last cablegram was confirmed by letter.

We had in use, at that time, a stationary riveter of the ordinary type, driving rivets in such portions of the ship as could be assembled and handled as a whole, namely, frames, water-tight doors, etc., such as are usual in ordinary merchant vessels. A very short experience with compression riveters showed that their great weight—reaching over 2,500 pounds for a six-foot gap—interfered too much with facility of handling to make them either useful or economical.

We then turned our attention to the pneumatic hammer, which delivers an almost continuous series of blows against the end of the chisel, calking tool, or rivet die. The hammer is light, powerful, short enough to go in between frame spacings, and small enough in diameter to get at rivets in corner angles. For rivets up to ¾ inch diameter it can be held in the hand, but for rivets of a larger diameter the hammer should be held in a device suitable to the location of the work on the vessel, for instance, shell device and deck device. It is, however, almost impossible to hold on to the rivet by hand unless a spring dolly bar is used instead of the heavy holding-on hammer used in hand riveting, the heavy holding-on hammer being fairly jarred off the head of the rivet by the rapidity of the blows from the pneumatic hammer, giving the holder-on no opportunity to bring his tool back into position between blows as in hand riveting.

PORTABLE PNEUMATIC YOKE RIVETER COMPLETE.

In connection with the above-mentioned pneumatic hammer there is used a simple pneumatic holder-on, consisting only of a cylinder carrying a piston, behind which air is admitted, the rod extending through the front head and being cupped out to go over the head of the rivet.

Combining these two machines with a yoke, the hammer being mounted on one arm and the holder-on on the other, makes a self-contained machine in which the yoke can be made very light, as it has to resist only the pressure of the air against the end of the holder-on cylinder, and the reaction of the hammer blows. Various sizes of these yoke riveters are used for riveting the center keelsons, longitudinals, side keelsons, etc. They are also extensively used for riveting certain parts of turrets, gun-carriages, etc., where first-class riveting is absolutely necessary.

For driving rivets in frames and brackets, intercostals and beam knees, etc., we use a jam riveter and pneumatic-holder-on.

The above descriptions will, I trust, make sufficiently plain the methods for driving all rivets that can be reached on both sides by a yoke or jam riveter. There remain three classes of rivets in a ship, as follows: (1) Those through decks and tank tops, mostly countersunk, and all driven downward from above; (2) bulkhead rivets, nearly all with full heads; (3) those in the outside of the vessel and all countersunk. These three classes must be reached by riveters on one side and holders-on on the other, without any connection whatever between them. The first class are most easily driven, and for them the hammer is attached to a universal swivel head, mounted on a pipe or T-bar. The operator raises the hammer to bring the flat die on to the rivet, and the pipe or T-bar being secured at the center, holds the hammer in position while the rivet is being driven. A second man with a pneumatic chipping hammer cuts off the surplus metal, and the riveting hammer being brought back on the rivet, a few seconds complete the operation. In this case the pneumatic holder-on is operated from below by a third man, being braced against the bottom of the ship or the next deck below.

For the second class, the hammer is simply held in the hands of the operator, said hammer having about a 4½-inch piston stroke, and as the die is cupped out to form the snap point, there is no tendency to slip off the point. The holding-on is done by a spring dolly bar, which I will explain later.

We now come to the third class, or shell rivets, which, in many respects, are the most important rivets in the ship, requiring the most careful workmanship and the best finish. Therefore it is a serious mistake for shipbuilders to attempt to drive shell rivets by pneumatic power until they have established pneumatic riveting on all inside work, because the men operating the tools should be accustomed to handling the hammers before being put on this important part of the work. It is evident at the start that the varying thicknesses of plates, frame flanges and liners, and especially the depths of countersink, render it impracticable to so gauge the length of rivet used that there will always be just enough metal to properly fill the countersink and finish the point, and that, therefore, as in hand riveting, a longer rivet must be used. After the point is beaten down and the surplus metal crowded off to one side, this surplus must be chipped off, and the point be finished up, rounded slightly, and any seams between the rivet and the plate driven together and closed. To do this a certain amount of freedom of motion must be allowed in the hammer, so that its axis may be inclined at a slight angle in any direction with the axis of the rivet itself.

This result is attained by mounting a pneumatic hammer in a device having a universal movement attached to the end of a T-bar, instead of its being immovably fastened to it. For bottom riveting there is a flat bar adapted so as to be mounted on the shell of a ship in any desired position. This flat bar carries an adjustable support, connected, by means of a swivel joint, with a holder in which is mounted an adjustable frame bar, pivotally supporting at one end a pneumatic hammer, and at the other an adjustable distance piece.

At one setting a space of 14 feet to 16 feet square can be reached with the above device, and when it is necessary to move the device to another position the change can be effected in about ten minutes. A spring dolly bar is used for holding-on, thus dispensing with the costly method of a wood backing, necessary when a pneumatic holder-on was used, as was the case a few years ago, and an ordinary pneumatic chipping hammer is used to cut off the surplus metal before finally finishing. It is evident that the freedom of movement of the hammer can be secured in other ways, such as a ball and socket joint of large radius, but we have found the above device more satisfactory and all that can be desired.

For riveting the side shell plating the same device is used, with one exception, and this is as follows: there is a holder provided with a T-shaped slot, the sides of which form a bearing for the T-shaped frame bar, while allowing said bar to be moved from one position to another in said slot; and a friction spring and set screw, respectively adapted to bear against the bottom of said frame bar when the latter is in position in said slot and to lock the frame bar in any desired position in said holder.

The spring dolly bar now used is made of a piece of 3-inch pipe about 12 inches long, having at one end an ordinary cast-steel handle, while at the other there is a bushing, through which a set screw holds the cup or snap. Inside the pipe there is a piece of round iron, about 6 inches long, backed up by a spiral spring.

The quality of the work done by all these machines, both inside and outside the shell, is first-class in every respect, and far superior to hand work, seeing that a rivet driven by a pneumatic hammer has to be about 12 percent longer than a rivet driven by hand, which goes to prove that the hole is better filled when the work is done by pneumatic tools, and such is the unanimous opinion of the inspectors who have been and are on duty in the American shipyards.

That this is natural appears from several considerations. The rivets are closed down more rapidly and at a much higher temperature, and, as it is always easy to bring the axis of the hammer in line with the axis of the rivet, and, in fact, natural for the men to do so, the rivet is plugged at once by the first blows of the hammer, thoroughly filling the hole throughout before the point begins to form. The tendency of hand riveters to save labor, to form the point without thorough plugging, leaving a rivet which, though looking all right and passing the tester, is liable to loosen afterwards in service from the constant jar and vibration of the hull, is, therefore, avoided. In many confined places, also, where only one man can strike, and the space for the swing of the hammer is confined to the frame spacing or less, hand rivets are very apt to be poorly driven, but it is evident that such considerations do not affect the machine, and that, if the pneumatic hammer can get to the rivet at all, it is as well put in as in the most open parts of the work.

As to the cost of pneumatic riveting, I submit the following figures, which are piece-work rates current in the States, also figures comparing them with the British piece-work hand rates. In making this comparison, I must call your attention to the fact that both day-work and piece-work rates in America are about 35 percent higher than in Great Britain. This is due chiefly to the cost of living being higher. So that the piece-work prices for pneumatic riveting in Great Britain should be one-third less than the prices paid in America.

Distribution.	No. of Rivets.	Diameter of Rivets. Inch.	Machine Rate, Each. Cents.	Hand Rate, Each. Cents.
Keel (flat)	6,217	1	2½	4½
Shell	21,628	⅞	1¾	3½
Shell margin (bilge single line)	1,122	⅞	3	4½
Longitudinals, open	24,632	¾	1¼	2¾
C. V. K. brackets	3,197	¾	1	3½
" "	.....	..	1¼	3½
" "	.....	..	1½	3½
Longitudinals under tank	664	¾	1¾	2¾
Longitudinals, bars	2,989	¾	1¼	2¾
Tank top stiffeners	1,129	¾	2½	3½
Tank top margin	4,033	¾	1½	2¾
Tank top rider	3,209	¾	1¼	2¾
Tank top lugs	1,520	¾	1¾	3½
Tank top	4,467	¾	1¼	2¾
C. V. K. cross vertical keelson	12,723	¾	1	3
Hold stringer	1,184	¾	1½	3
Floors	123	¾	1¼	3
Floors (odd)	5	¾	2	6
C. V. K. (odd)	38	¾	2	6
Bulkheads	1,318	¾	1¼	5
"	3,051	¾	1¼	3¼
"	231	⅝	1½	2½
Total	93,480			

The foregoing was compiled from an actual test covering a period of three weeks at the Chicago plant of the American Shipbuilding Company.

Total cost of job by hand would have been..... $2,986.87
Total cost of job by machine was..... 1,403.31

Saving of machine over hand work..... $1,583.56

Average cost per rivet of hand work..... 3.19 cents
Average cost per rivet of machine work..... 1.50 "

Average saving per rivet of machine hand work. 1.69 "

Average cost of machine riveting was 47 percent of hand cost.

If the above 93,480 rivets had been driven by pneumatic tools in a vessel building in a British shipyard at piece-work rates one-third less than are paid in America, the result would be as follows:

Distribution.	No. of Rivets.	British Pneumatic. Price per 100. s. d.	British Pneumatic. Total Cost. £ s. d.	British Hand. Piece-work. s. d.	British Hand. Total Cost. £ s. d.
Keel (flat)	6,217	7 0	21 15 2	11 10	36 15 8
Shell	21,628	5 0	54 1 5	8 8	93 14 5
Tank margin	1,122	8 4	4 13 6	10 0	5 12 2
Longitudinals, open	24,632	3 6	43 2 1	8 6	104 13 9
C. V. K. brackets	3,197	3 6	5 11 10	8 6	13 11 9
Longitudinals under tank	644	5 0	1 13 2	9 6	3 3 1
Longitudinals, bars	2,989	3 6	5 4 7	9 6	14 3 11
Tank top stiffeners	1,129	7 0	3 19 0	10 0	5 12 11
Tank top margin	4,033	4 2	8 8 0	10 6	21 3 6
Tank top lugs	1,520	5 0	3 16 0	10 0	7 12 0
Tank top rider	3,209	3 6	5 12 4	10 6	16 16 11
Tank top	4,467	3 6	7 16 4	10 6	23 8 0
C. V. K. vertical keelson	12,723	2 10	18 0 6	8 6	54 1 5
Hold stringer	1,184	4 2	2 9 4	8 6	5 0 8
Floors	123	3 6	0 4 4	8 6	0 10 5
Floors (odd)	5	5 9	0 0 4	11 6	0 0 7
C. V. K. (odd)	38	5 9	0 2 2	11 6	0 4 4
Bulkheads	3,051	4 2	6 7 1	7 0	10 13 7
			£192 17 2		£416 19 1
					192 17 2

Amount saved by machine over hand (British rates) £224 1 11

The amount that should be added to machine cost to cover interest, maintenance of plant, and operation of compressor, is about 15 percent of the gross earnings of the tools.

It is only fair to mention that, at the time the above test took place, about seven years ago, pneumatic tools were not so perfect as they are to-day, and their application to ship construction has been very much simplified. For instance, when driving bulkheads and shell it was customary to use a pneumatic holder-on, which necessitated something to act as a backing for the tool, said backing having to be built up, which added considerably to the total cost of riveting, whereas now a spring dolly bar is used, which the holder-on holds in his hands; again, the shell device for holding the riveting hammer while driving the rivet has been very considerably improved, and can be removed from one position to another on the ship in less than one-fifth the time required to remove the old device.

In conclusion, I should like to say that, while visiting the various shipyards on the Clyde, one of the most prominent shipbuilders called my attention to the fact that since commencing to use pneumatic tools they have turned out 20 percent more tonnage, from the same building berths, than they did before. So there is not only a saving in the reduced price of work done by pneumatic tools, but also a great saving in time, which is a very important item to a shipbuilding company which is limited

as to space and has not sufficient berths to accommodate all the vessels under order.

Thus it will be seen that, while pneumatic tools are still only in their infancy, there is no limit to the advantages that shipbuilders and engineers can gain by their use in connection with shipbuilding and engineering. In addition to the tools already mentioned, there are now on the market pneumatic hoists, rammers, molding machines, wood-deck calking machines, wood-deck planing machines, painting machines, and large hammers for blacksmith work.

of dealing with plates of this same weight, while a beam bending machine can handle anything up to 12 inches in size. There is a large compressor plant for generating compressed air to be used in drilling, chipping and calking, a large plate scarfing machine, multiple drilling machines, edge planing machines, a large manhole punch, capable of punching an entire manhole at one stroke up to 24 by 17 inches, besides the various smaller tools in the way of saws, hammers, etc., necessary for the operation of such a plant. The equipment includes also a 6-ton locomotive crane traveling along the side of the dock.

GENERAL VIEW OF THE DOCKYARD OF THE HALIFAX GRAVING DOCK COMPANY.

Repair Work in the Dry Dock at Halifax.

Considerable interest attaches to the photograph on this page showing the North German Lloyd steamship *Bremen* in dry dock at Halifax for repairs necessitated by a peculiar accident which occurred last fall. It will be recalled that this steamship left New York, and had proceeded about twenty-four hours on her way to Europe, when the breaking of one of the propeller shafts allowed that propeller to slip aft in such a way as to foul the other propeller, and entirely stop the ship's progress. The arrangement of the propellers was such that the diameter was slightly greater than the distance between centers of shafts, so that the propellers overlapped, and, as a result, one was necessarily placed forward of the other, and it was the shaft of the forward propeller which caused the difficulty.

As placed in the dry dock, this ship with stores and cargo represented a total weight of 16,800 tons and the draft was 25 feet 6 inches aft and 23 feet 6 inches forward. The *Bremen* has a length of 525 feet 1 inch, a beam of 60 feet 2 inches and a depth of 34 feet 8 inches, the tonnage being 11,570 gross and 7,202 net. Propulsion is by means of two four-cylinder quadruple expansion engines, with cylinder diameters 27½, 40¾, 59 and 83½ inches, and a common stroke of 53 inches. The ship was built by Schicau, at Dantzig, Germany.

The repair shops of the Halifax Graving Dock Company, Limited, are equipped with modern tools and all facilities for the performance of ship repairs. The plate bending rolls have a length of 34 feet, and are capable of handling plate up to 1½ inches in thickness. Punching and shearing machines are capable

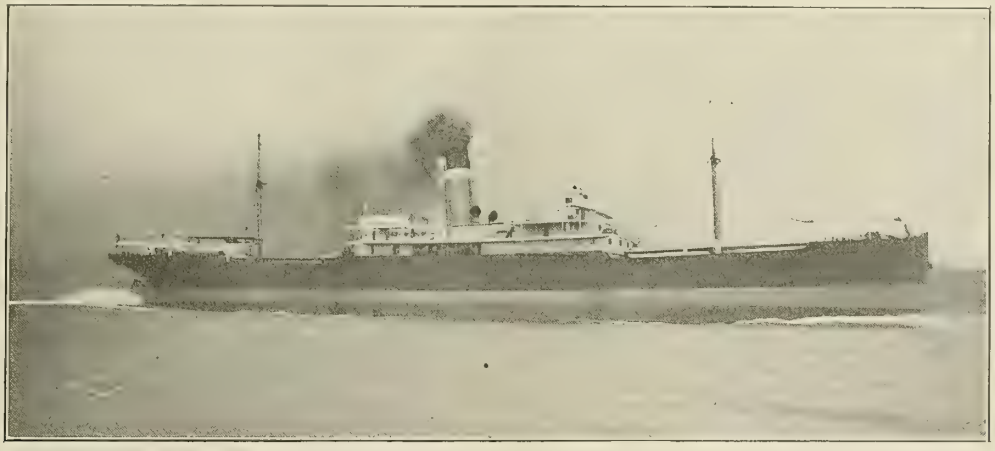
Additional interest is lent to the photograph by the fact that in the background are seen the five ships of the British Second Cruiser Squadron, which visited New York in November. Four of these are in a group in the left background, while the *Drake* is alongside a pier, directly back of the foremast of the *Bremen*.

THE CITY LINER CITY OF GLASGOW.

The City line of steamers from Glasgow and Liverpool to India is one of the oldest shipping companies in the world. It was originated in the year in which the first Cunard steamer crossed the Atlantic, and like the Cunard Company it had its inception in Glasgow. The originators were the firm of George Smith & Sons, soft goods merchants in Glasgow, who were led into shipping through having to take over a Canadian barque of 300 tons in payment of a bad debt. They at once built two or three more, and started the City line of sailing packets to the East, and in process of time they dropped the sailers and built a fleet of steamers, which acquired and have retained first place among the tea-carriers because of their construction and management. The City fleet now consists of about twenty steamers trading regularly with freight and passengers between Glasgow, Liverpool, Calcutta, Bombay and Karachi. Although in 1903 amalgamated with the Ellerman Lines, Limited, the City line is still managed by the old firm.

From the yard of Workman, Clark & Co., Belfast, has now been launched a new steamer for the line. The *City of Glasgow*

is of about 6,400 tons, and is intended for passenger and cargo service between Liverpool and Calcutta. The arrangement of the accommodation for first-class passengers is on the bridge deck, and for second-class in the poophouse. The holds have been specially arranged for the reception of bulky cargo, with latest facilities for rapid loading and clearing. The construction of the hull and machinery was carried out under the survey of the British Corporation of Shipping to qualify for their highest



THE CITY OF GLASGOW ON HER TRIAL TRIP.

class, and with the Board of Trade requirements for a passenger steamer. On her trial cruise an average speed of 15 knots was maintained.

The *City of Glasgow* has accommodation for 136 passengers. Special attention has been given to the arrangements of the five cargo holds, to enable her to receive the largest and bulkiest items of cargo, such as boilers, locomotives and railway cars. The cargo gear consist of eleven steam winches, with suitable derricks swung from the masts, and fitted with the necessary tackle for expeditious handling of cargo.

The staterooms for the first-class passengers are commodious and well appointed, and are placed in a large house on the bridge deck, as well as on the upper deck at the forward end of the bridge space. The dining saloon is a spacious and handsome apartment which provides accommodation for over eighty diners. The wainscotting is of light unpolished oak, neatly paneled, and the furniture is to match. The saloon is lighted by large cottage windows and a large dome, and is built on the bridge deck. The pantry and other offices are conveniently arranged. A large and well ventilated nursery is provided. From the dining saloon a stairway leads to the upper bridge deckhouse, containing additional staterooms and an artistically furnished ladies' room, which is lighted by cottage windows. A piano, bookcase, writing tables, and other conveniences are provided. At the after end of the same deck is situated the smoke-room.

The staterooms for the second-class passengers are provided in the poop, as well as a dining saloon with pantry adjoining, and other necessary conveniences. On the poop deck an entrance house and smoking room are placed, approached by a stairway from the second-class alleyway. A barber's shop has also been fitted.

Rooms for officers and engineers are placed in a deckhouse at the after end of the bridge deck. The Lascar crew, seamen and firemen, are housed at the after end of the poop. Their quarters are approached by a companionway from the poop, where their native galley is situated.

THE CITY OF GLASGOW ALONGSIDE PIER.

The propelling machinery consists of a set of quadruple expansion engines, capable of developing 4500 I. H. P., and supplied with steam from four single ended boilers of the multitubular type, working under Howden's system of forced draught. The main engines have cylinders 27½, 39½, 56½, and 81 inches in diameter, with a stroke of 54 inches and a working pressure of 215 pounds to the square inch. The four boilers are 15 feet

6 inches in diameter by 12 feet long, with a total heating surface of 11,000 square feet, and 280 square feet of grate surface (39.3 to 1). The one propeller has manganese bronze blades.

The *City of Glasgow* is fitted with the newest pumping arrangements in the engine-room—Weir's pumps and evaporator, winch condenser and electric engine and dynamo (both to light the ship, including cargo clusters for working the cargo, and to drive the fans in the passengers' staterooms). She is also fitted with a refrigerator sufficient to keep all provisions fresh and in good condition in the tropics. Benjamin Taylor.

PHYSICAL LABORATORY OF THE PHILIPPINE NAUTICAL SCHOOL.

Need for an American Nautical College Stirred by the Existence of the Philippine Nautical School.

BY FRANK VAN VLECK, PH. D.

The needs of a higher nautical education for the American youth contemplating a marine career is perhaps best emphasized by the very scarcity of schools granting even the semblance of nautical instruction. If America is to sustain its waning maritime prestige, it must do it by affording occupation to the sea personnel of the present, and by far more systematic efforts to train men for the sea profession of the future. If we are to have a mercantile marine worthy of the name, we must soon begin to prepare the men for the responsibilities of new fleets The great steamship lines all recognize that the great administrative officers of the future, the managers, the captains, the chief engineers—yes, and even subordinate officers, must be educated and trained men—educated to the profession of the sea; and that the forecastle and the steerage alone will not afford the training for the most exact seamanship, nor certainly for the finer arts of commercial diplomacy, international law, rare business judgment, and the varied requirements of a general linguist.

Yet we as Americans practically do nothing to train our youth for the sea career. Our colleges turn out graduates by the thousands for almost every niche in the railroad profession, or for manufacturing life. Some paltry three or four turn out a handful of naval architects, but not one institution fits young men for the maritime profession. The great Naval Academy is not included, for this is a closed college save for the elect, and trains solely for the navy, and not in any wise for the benefit of the mercantile marine.

The ambitious young American who desires to train and educate himself for the sea profession, in a manner adequate to what all other professions and industrial life demand, simply cannot gain this education and training in America. He must either give up such hope, or go to Europe for the training, or, as thousands of other young Americans have done, stand idly by and see the freshly naturalized foreigner, trained in a European nautical school or college, gain the coveted distinction of treading the bridge in command. Even in Europe there are but few such institutions that will admit foreigners—Americans. This our own navy discovered when it was sought to train young naval constructors at the Ecole Maritime of France, or Royal Naval College of Greenwich.

As it is impossible to obtain the higher nautical education, our young American, with the love of the sea unquenched, probably then contents himself with the secondary education to be found in a state school ship, if he is fortunate to live in one of the three States of the Union which maintain these ships. If not a resident of these States—it were far better that he were—a "Filipino." Even should he be a resident of one of these States, perhaps his wiser parents object to his sea education in an atmosphere in which the public regard the school-ship as synonymous with a reformatory. For somehow the opinion of the school-ship seems not to be much in advance of the cat-o'-nine-tails period. Of course, this is unfounded. This, then, is the condition of American nautical education—none worthy of the name.

Amid this discouraging outlook, it is interesting to look across the seas to our insular possessions, and behold a nautical school in full swing, braced by the prestige of seventy years of age—a school established by the Spaniards at Manila, and taken over by the American army of occupation, and at once administered by able officers of the United States navy. Thus accidentally has our nation provided for the Filipino youth the means for a nautical education, which it has not in any equivalent provided for any of its own sons.

The very existence of this Philippine Nautical School is so little known of, that it almost seems as a discovery, consequently the accounts submitted of it, abstracted from the Reports of the Philippine Commission, may prove of more than the usual interest.

The Philippine Nautical School was established in 1839 by the Philippine Board of Commerce, and, as its name implies, its purpose is to give theoretical and practical instruction in navigation. The original home of the institution was destroyed by the earthquake of 1863, and since that time the school has suffered three changes of location. Its present location is at No. 97 Calle Santa Elena, district of Binondo, in the city of Manila. With

the change of sovereignty the school passed to American hands, and Lieutenant-Commander Cottman, Lieutenant Cooper, Lieutenant Townley, and Lieutenant-Commander Knapp, of the United States navy, were successively placed in charge. Under the administration of Lieutenant-Commander Knapp English text-books and American methods of instruction were introduced, and the school reached a very high degree of excellence. When Commander Knapp was relieved from duty in the Orient by the Navy Department, Lieutenant-Commander Glennon was detailed for duty as superintendent of the school and rendered excellent service until November 1, 1902, when he was relieved from duty. Since his relief the bureau of education has been unable to secure the services of a naval officer as superintendent. From 1903 until the end of the last school year the assistant superintendent was in charge of the school and carried on the work of theoretical instruction along the lines prescribed by his predecessors. At the beginning of the last school year Mr. C. L. Jenkins was placed in charge.

The school is well equipped with nautical instruments, and has a good telescope, tellurians, celestial and terrestrial globes, maps, charts and other supplies. It is poorly housed, however, and as soon as insular finances permit, a vessel of sufficient size will doubtless be secured as a home for the school, and for the purpose of giving the students practical instruction in seamanship. The course prescribed is four years, and is as follows:

First year: Arithmetic, algebra, plane geometry, geography, English, and seamanship.

Second year: Algebra, plane and solid geometry, plane trigonometry, physics, geography, drawing, English and seamanship.

Third year: Spherical trigonometry, physics, electricity and magnetism, physiology and hygiene, astronomy, navigation and nautical astronomy, seamanship, and English.

Fourth year: Chemistry, Philippine and United States history, navigation and nautical astronomy, English and seamanship.

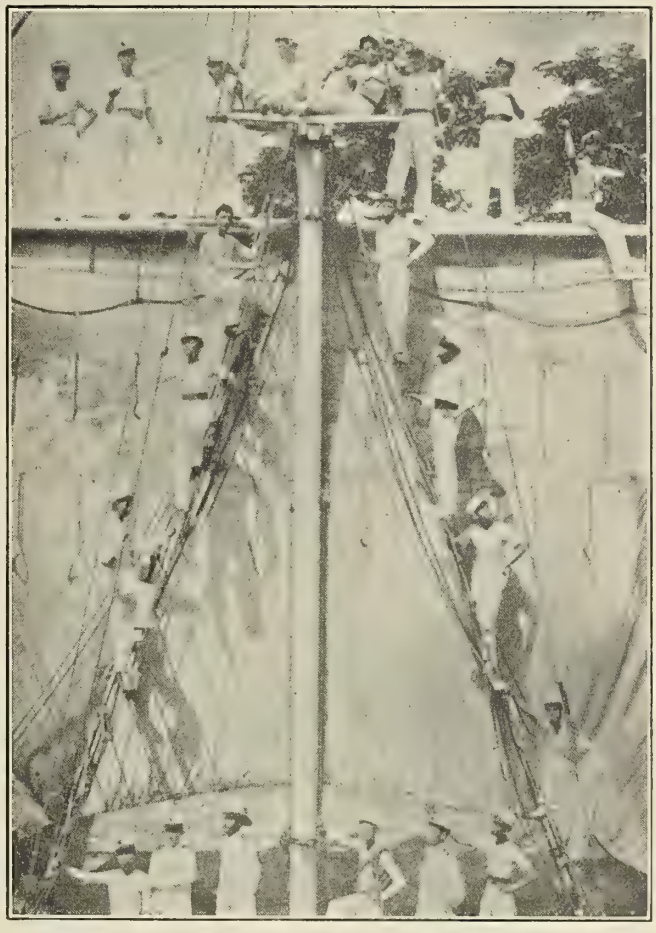
To secure the proper physical development of the pupils, setting-up exercises, infantry and seamanship drills, fencing and singlestick are prescribed, and boxing, football, and baseball encouraged. The students display great proficiency in mathematics, and evince a very commendable interest in their chosen specialty. The school enrollment is 121, and the average attendance 115, or 95 percent of the enrollment.

The school opened on June 30, 1902. The number of students was 73, divided among the four classes, as follows: First class, 16; second class, 8; third class, 19; fourth class, 30. None were added to the first class, and 1 left school, leaving 15 to graduate. One entered the second class and 3 left during the school year, leaving 6 at the close of the year. Three entered the third class, and 4 left, leaving 18 at the close of the year. Ten entered the fourth class, 11 left, and 1 died, leaving 28. This gives a total of 67 students enrolled at the end of the year. The attendance was fairly good; 94.45 percent for the first class, 98.59 percent for the second class, 90.86 percent for the third class, and 92.86 percent for the fourth class. The attendance for the entire school averaged 93.27 percent.

The entering class was very poorly prepared. Some system of selection by division superintendents or governors of provinces of bright boys would remedy this. Not more than five or six boys in the school ever had any instruction by American teachers before entering the nautical school. With such a state of affairs existing it is very difficult and it might be said, almost impossible for the instructors to do good work. By good work is meant turning out good products, for results are almost the only things by which to judge a workman.

The school is well supplied with books; with other essentials not so well. A laboratory is needed to supplement the text-books in chemistry and physics. It is understood that apparatus for both has been ordered from the United States. An entire change in the text-books, from Spanish to English, has been effected, and it is hoped that the best results will follow. The Filipino is said to be deficient in reasoning power, and this is true to a great extent. Yet the results obtained in sciences have been very good. In many instances wonderful progress has been shown. It is believed that on the completion of their course in the nautical school, four of the six boys in the highest class could stand in the first third of the entering class in the scientific department of any of the universities or colleges in the United States. Their work in mathematics is superior to that of the average American entering class. The corps of instructors consist of industrious teachers, having a thorough knowledge of their subjects, and are popular with the students.

Last year there were placed about three-fourths of the students in the lower classes on the boats of the different steamship companies in the islands, for practice during the vacation months. This has proved to be a valuable adjunct to their study in the school. The steamship companies deserve thanks for their assistance. Some time in February it was recommended that the graduates be placed on the coast-guard service boats, which vessels constitute the insular navy. An appropriation was expected to be made at any time and so the boys were kept waiting. Deciding that no appropriation would be made, the old method was returned to of getting positions for the boys on the merchant boats. There were 15 students in the graduating class last March. Three of them are now mates drawing salaries of $110 Mexican per month and food. One has been offered a like inducement, but up to the present time has been unable to secure a mate's certificate by reason of his being under the minimum age of 18 years. One of them receives $70 a month and food, and 9 others are getting only their food and instructions from their captains in return for their services as mates or midshipmen. I have been assured that all will get positions as mates just as soon as they have had sufficient experience to obtain certificates.



AT DRILL ON THE PRACTICE MAST AND RIGGING.

Six boys graduated from the school one year ago last March. One is first officer on the *Buen Viaje,* plying between Manila and Singapore. He gets $175 Mexican per month and everything found. Another receives $110 and food, another $45 and food. One is on a large Japanese liner, one is a midshipman, getting his food only, and the sixth of the class is doing nothing. It is understood that his parents are wealthy, and that he will not take a minor position.

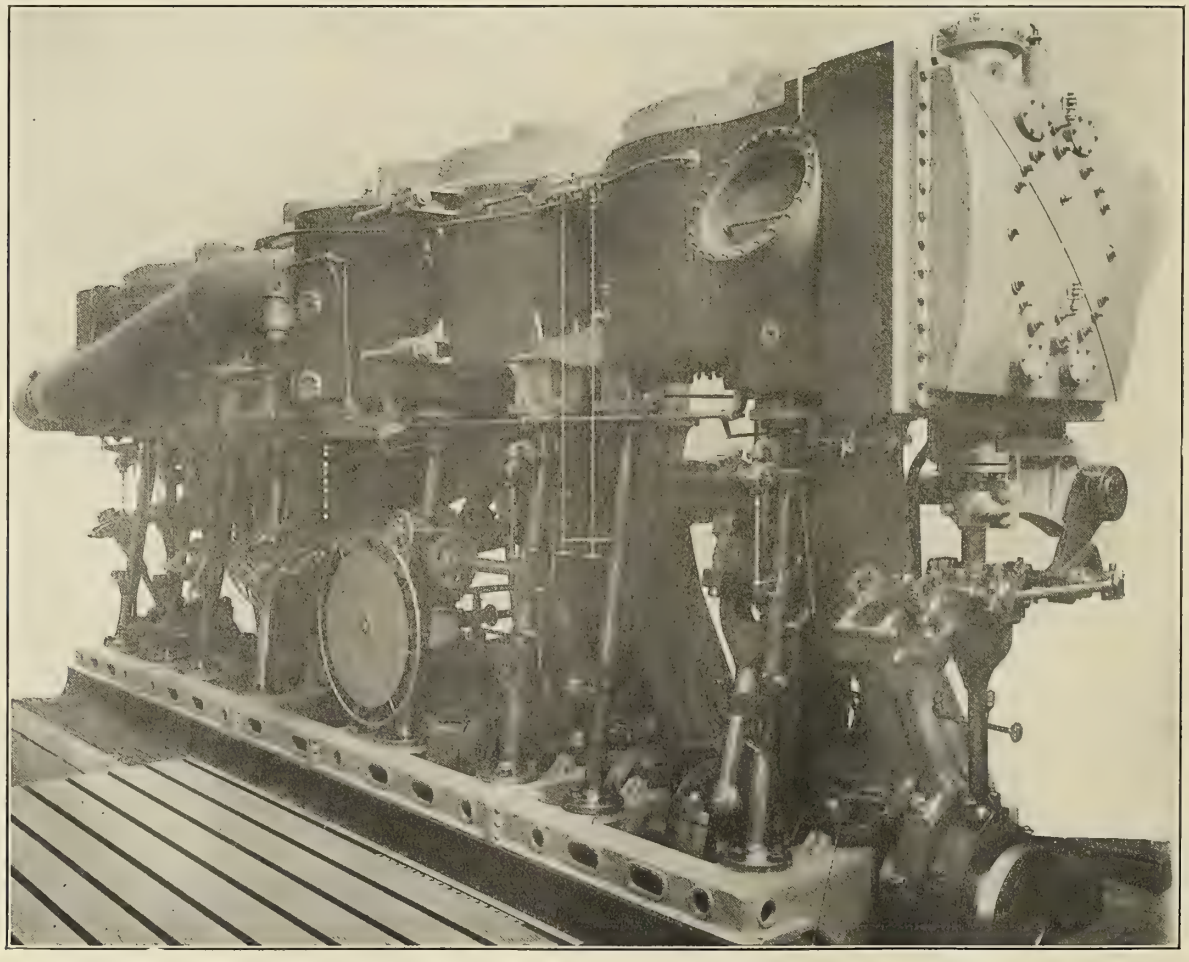
All the graduates were informed that the Commission had passed an appropriation to place 12 of them on the coast-guard service boats. The appropriation was to cover their expenses as marine cadets, the amount of the expenses not to exceed $2,000 for a period of six months. Lieutenant-Commander Helm, chief of the coast-guard service, stated that his interpretation of the ruling of the Commission was that it covered the cost of uniforms and food up to $15 gold per month for each midshipman. The latter was based on the government allowance for the officers on the coast-guard boats. But these men do not find that this sum is sufficient. It costs them from $10 to $20 Mexican per month in addition. Commander Helm and the superintendent of the nautical school decided that it would be better to leave the graduates where they are, for the present at least.

THE FIRST-CLASS ENGLISH ARMORED CRUISER BLACK PRINCE.

BY FRANK C. PERKINS.

The *Black Prince* is the first of six first class armored cruisers of the *Duke of Edinburgh* type, which are under construction, four being built in the yards of private contractors, and the remaining two at the Royal dockyard at Pembroke. The *Black Prince* was launched by the Countess of Selborn, at Canningtown, at the shipyard of the Thames Iron Works Shipbuilding and Engineering Company, Limited. She was commenced in January, 1903, and was completed and commissioned for sea in March, 1906. This is the first English war vessel that this firm has completed ready for commission, although they have always done so in the case of vessels for foreign navies.

The ship is 480 feet long between perpendiculars, with an extreme beam of 73½ feet, the depth from the outer bottom to the upper deck being 40 feet 9 inches, the draft forward 26½ feet, and the draft aft 27½ feet. The displacement is 13,660 tons, while the indicated horsepower of the machinery installed for propelling the vessel was designed to be 23,500. The designed speed was 22.33 knots. On the official trials the speed



STARBOARD MAIN ENGINE (12,000 HORSE POWER) OF NEW ARMORED CRUISER BLACK PRINCE.

The average cost of building and completing for sea the ten cruisers of the *Kent* class (English, 9,800 tons) was $3,674,450. The cost of the annual upkeep is about $82,500 for each ship for coal and sea stores, while it is estimated that the average annual cost of repairs for the first eight years will be about $27,500. These ships are very similar to the American cruisers of the *St. Louis* class, but have better speed.

Four of them visited New York last fall, as part of the Second Cruiser Squadron.

obtained was 1.32 knots in excess of her guaranteed contract speed, the rate being 23.65 knots.

The propelling machinery, which was constructed at the company's engineering department at Greenwich and Deptford (formerly John Penn & Sons), consists of two sets of inverted four-cylinder triple expansion engines, working at a pressure of 205 pounds in the high-pressure valve chest. The high-pressure cylinder measures 43½ inches in diameter, and the intermediate 69 inches, while the diameter of the two low-pressure cylinders

is 77 inches, with a stroke of 42 inches. The engines are balanced on the Yarrow-Schlick-Tweedy system, and arranged to run at a speed of 135 revolutions per minute.

There are two separate and independent condensers to each set of engines, and two independent twin air pumps arranged to pump from both condensers.

The boiler installation consists of twenty Babcock and Wilcox boilers and six cylindrical boilers, working with closed stokeholds and forced draught, the working pressure of all the boilers being 210 pounds per square inch.

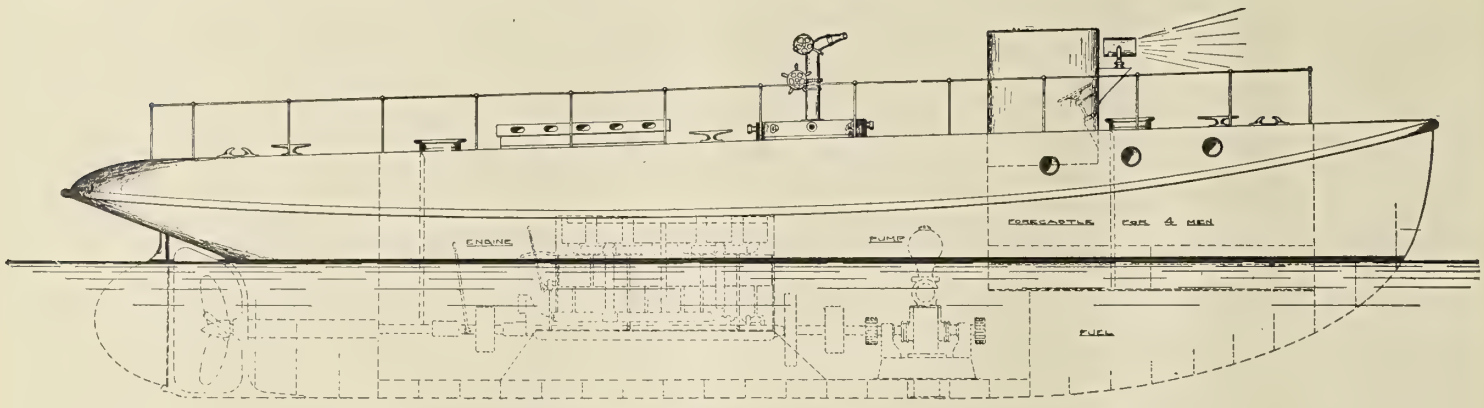
There are two complete sets of evaporating and distilling machinery, built by Caird & Rayner; and two vertical double cylinder steam steering engines and gear built by Bow McLachlan. The vessel is equipped with the latest and most complete electrical devices, all of the fans and ventilators being electrically driven, and of the Sirocco type, the motors being installed by the electrical department of the Thames Iron Works..

An electrically driven ice machine and two sets of air compressing machinery are installed, the electric current being supplied from four steam driven electric generator sets, the engines being of the Peter Brotherhood type, and the dynamos designed and constructed by Lawrence Scott. The coal, ash and boat hoists are all electrically driven. She is lighted up with about 1,400 incandescent lamps, has an electrical helm indicator, and is well served with electric bells, telephones, etc. The whole of the electrical work, with the exception of the capstan gear, is made and fitted by the firm, as well as all the ventilating and pumping work, etc. The double bottom is arranged to carry heavy oil, and is fitted with pumps, pipes and filters, to enable the boilers to use oil as fuel if necessary. The coal bunkers can carry a maximum of about 2,000 tons of coal. There are two capstans, the one forward driven by steam, and the after one electrically.

There is a complete armor belt running from stem to stern, the thickness amidships at waterline being 6 inches, and tapering at forward end to 4 inches and 3 inches aft. The citadel, which is rectangular in shape, is protected by 6 inches of armor, and carries ten 6-inch breech loading guns. Eight are broadside guns, while the two after ones can fire both athwartship and fore and aft. On the upper deck there are five 9.2-inch guns in barbettes, protected by 6-inches and 3-inches of armor, while forward on the forecastle is another 9.2-inch gun, making six in all. The foremost 9.2-inch gun and the aftermost one are situated at the middle line, so that an arc of fire of 310 degrees can be obtained. The other four 9.2-inch guns are placed at the sides of the vessel, and nearly over the ends of the citadel, and each of these commands a fire of 160 degrees. The shelter decks are well manned with 3-pounder quick firing guns, some 28 in number. There are also two Maxims and two 12-pounder 6-hundredweight guns, for boat and field use. The whole weight of armor is about 1,600 tons, exclusive of the protective decks.

ENGLISH ARMORED CRUISER BLACK PRINCE, 13,660 TONS, 23.65 KNOTS.

The battery has a protective deck covering of 1-inch steel, which is continued forward on the main deck. In addition there is the usual protective deck ¾-inches thick at the waterline running right fore and aft. The 6-inch guns are separated from each other by 2-inch splinter bulkheads. The conning tower is of 10-inch steel, provided with the usual armor tubes for carrying the leads of shafts, pipes, etc., from the shelter deck to within the armor protection. There are three 18-inch torpedo tubes, one on each side and one at the stern, all under water. One of the new features in the design is the placing of the shell rooms in the ammunition passages, close to the ammunition hoists, thus saving a deal of time in getting the shells to the guns. The 6-inch ammunition hoists have electric motors, while those to the 9.2-inch guns are worked hydraulically.



COMBINED OUTBOARD AND INBOARD PROFILE OF NEW MOTOR FIRE BOAT.

A New Motor Fire Boat.

Designed for using a gasoline engine in place of a steam engine, and for fire service in shallow waters, a new type of fire boat has been developed with a draft of 5 feet and a height above water line to top of steering shield of 8½ feet. This latter allows the boat to pass under bridges in cities intersected by rivers or canals.

As may be seen from the illustrations, the boat is propelled by a single 6-cylinder engine, which is of the Standard pattern. The engine is direct-connected to the pump by means of a clutch coupling, which permits its being disengaged at any time when the propulsion of the boat is necessary, while similar coupling at the other end permits disengaging the propeller and utilizing the entire power upon the pump. The capacity of the latter is 2,000 gallons per minute against a pressure of 150 pounds. The deck nozzle is placed at the longitudinal center of the boat, thus obviating any tendency for the reaction of the force of the stream to turn the bow or stern. The circular deck tower upon which this standing nozzle is placed has eight universal hose couplings which will fit any hose, and by means of which the streams may be carried in any direction required or into buildings. The standing nozzle and each of the eight connections may be operated independently.

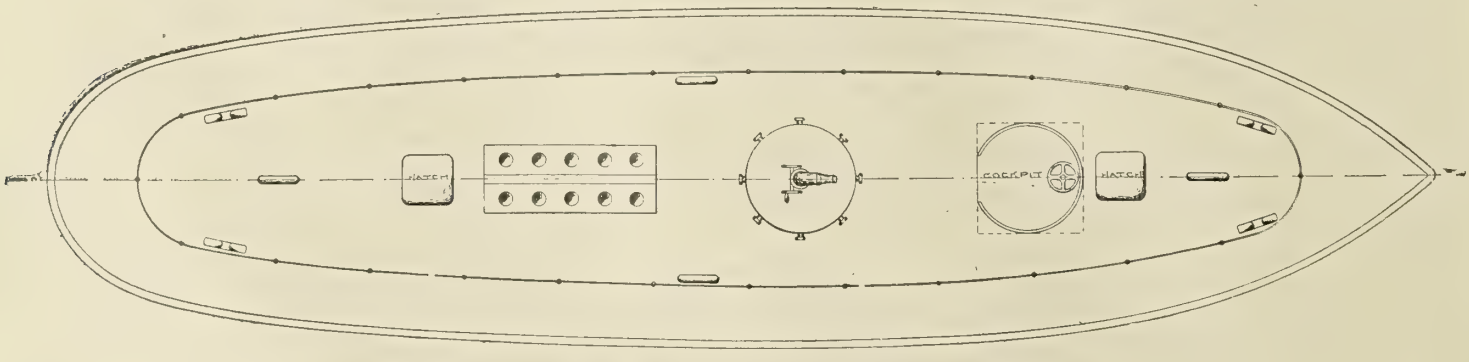
The fuel is carried in a water-jacketed tank below the water line, in order to insure against the possibility of the fumes' being ignited by the heat of any fire which might be fought. The decks are cooled by the circulation of water through the hollow hand rail shown in illustration, there being small holes two inches apart on each side to serve for the purpose of throwing a spray all over the upper part of the vessel. The very heavy construction and specially designed form combine with high propelling power to make the boat an excellent ice-breaker for winter service.

The length over all is 51 feet, with a length of 45 feet 6 inches on the water line. The molded beam is 12 feet. It is stated that the cost of building one of these boats is about one-third that necessary for the type of steam fire boat now in common use.

The keel is of the flat plate type, 18 inches wide and 15 pounds thick; the stem, which is of wrought iron, measures 5 by 1½ inches; the stern post, rudder post and arch are also of wrought iron, 5 by 2 inches, with a shoe extending 3 feet into the hull. The frames are angle bars 3 by 2½ inches by 6 pounds, spaced 18 inches, and in one length from keel to deck. Reverse frames are angles 2½ by 2½ inches by 5 pounds; they extend along tops of floor and up the frames in one piece to a point 6 inches above the bilge keelson, and are fitted on every frame. The floors are 12½ pounds thick and measure 9 inches in depth, except that under the engines and at the ends of the vessel the depth is increased to fit the requirements. They are fitted in two pieces separated by the center vertical keelson. The latter is of the same weight and depth as the floors, and is connected to the keel by double angles 3 by 3 inches by 7 pounds. A bilge keelson on each side extends all fore and aft, and consists of an angle 3 by 2½ inches by 6 pounds. Deck beams are also 3 by 2½ inches by 6 pounds, fitted in one piece, and connected to frames by triangular brackets 12½ pounds thick and 30 inches long.

The outside plating of the hull is of mild steel with strakes lap-jointed, and with liners fitted between the frames and the outside strakes. The plates are fitted in lengths of about 15 feet, all butt straps being double riveted. The weight throughout is 15 pounds, the plating being doubled at the water line for a distance of 15 feet aft from the stem. The deck plating is 10 pounds, lap-jointed.

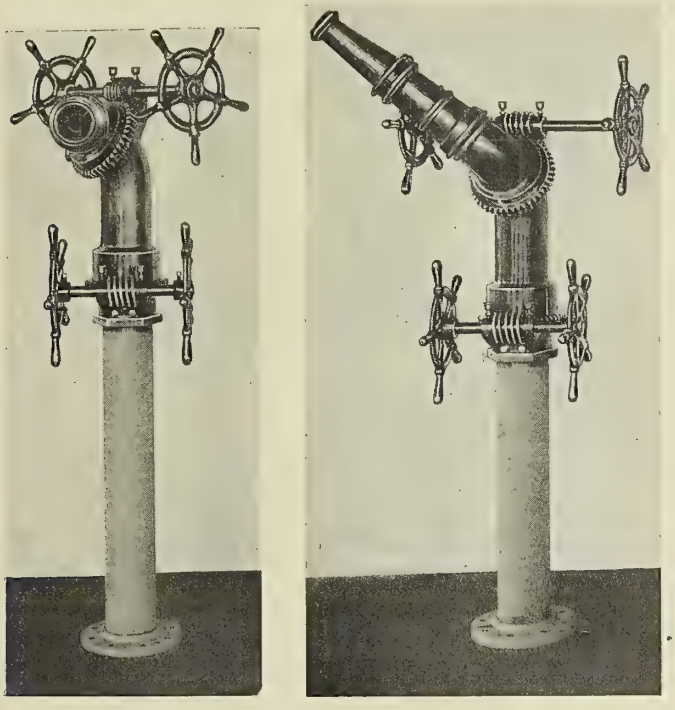
The engine foundation consists of high floors as mentioned in connection with the framing of the vessel, and is lightened by 6-inch holes. In connection with these are fitted longitudinal plates of 15-pound steel. The engine bearer angles are 3 by 3 inches by 7 pounds. The rudder has a wrought iron frame covered with double plates, the top of the stock being keyed to take the quadrant. The diameter of the stock is 4 inches. The steering cockpit has a floor 15 inches below the deck, the sides



DECK PLAN OF FIRE BOAT, SHOWING ARRANGEMENT OF NOZZLE AND FIRE TAPS.

above deck being circular and of double plating with 1½-inch air space between. The outside plating is 7½ pounds and the inside 2½ pounds, the ordinary stiffeners being used as distance pieces. The fuel tank, which has a capacity of 300 gallons, is made of 7½ pound galvanized plates, and is located forward just abaft the forefoot.

The engine, which is of the reversing type, with single acting trunk pistons, has six cylinders of 12-inch bore and 14-inch stroke. They are mounted on fourteen steel stanchions, and are provided with water jackets. The crank shaft has a diameter of 4½ inches and is of forged steel, the cranks being set 120 degrees apart and balanced. The bearings of manganese bronze are of



NOZZLES, SHOWING FLEXIBILITY OF DESIGN.

the box type. The thrust block is constructed on the bed plate of the engine, and forms a part of the after crank bearing, which is also of manganese bronze. The air pump for compressing air for starting is operated from an eccentric on the main crank shaft.

The exhaust valves are driven by a horizontal cam shaft operated by worm gearing, and are water cooled. The igniters, which are tipped with iridium spark tips, are driven positively from the main cam shaft. Lubrication from a main central tank is operated by pressure to sight feeders located on the different bearings and cylinders. Water circulation will be provided by means of a pump driven by gear on the main shaft. Water is drawn from the sea and finally discharged into the exhaust pipe, condensing the products of combustion. The entire contents are then discharged overboard close to the water line, doing away with excessive noise. The propeller is three-bladed, of manganese bronze, and has a diameter of 48 inches.

The pump is of the Silsby rotary fire pattern, especially designed for strength, compactness and simplicity of operation. The working parts consist of a pair of corrugated cams which revolve together within the elliptical case. The ends of the teeth which bear against the inside of the case are fitted with metallic packing strips pressed out by springs, thus insuring a perfect vacuum and the following up of any wear which may occur. The water enters at the bottom and is discharged at the top, in a stream which is uniform and steady. All parts of the pump in contact with water are of manganese bronze. There are three discharge outlets, one being used for the main nozzle and the other two for the eight hose connections. The piping is of copper.

The revolving fire nozzle is operated by a worm gear, the shafts of which are of steel. The turret proper is made of steam brass and the operating parts of phosphor bronze. The design is sufficiently heavy to withstand all strains and pressures to be met in service. The turret leaves an unobstructed passage for the water. The joint is so constructed that water cannot accumulate, to freeze in the winter time, or to deposit sand or sediment. The gears are cut phosphor bronze. The turn table joint has a long sleeve to withstand the heavy reaction of the stream. The inlet has an inside diameter of 4 inches. Five nozzles are provided, of steam brass, 1½, 1¾, 2, 2¼ and 2½ inches in diameter.

N. C. Cushing.

Large Dredger for Natal.

The new powerful sand pump dredger *Cetus*, recently launched by William Simons & Company, Limited, Renfrew, Scotland, and built to the order of the Natal government, has just completed her official steaming and dredging trials on the Clyde. The sand-pumping machinery was subjected to very exhaustive trials at Brodick Bay, when the vessel's hopper, which has a capacity of 3,000 tons, was loaded with sand well within the contract time. On completion of the pumping trials the dredger proceeded to Skelmorlie, where four runs were made on the Admiralty measured distance, when a mean speed of 10.3 knots was easily obtained, which is considerably in excess of the specified speed.

The dimensions of this large twin-screw suction pump dredger are as follows: Length, 301 feet; breadth, 47 feet, and depth

THE DREDGER CETUS.

21 feet 3 inches. She is fitted with the builders' patent sand-trapping arrangement. The centrifugal suction pumps are two in number. The large main suction pipe of the *Cetus*, capable of dredging to a depth of 46 feet, has an internal diameter of 44 inches, is fitted in a central well at the forepart of the ship, and controlled by powerful hydraulic gear fitted on the upper deck. This pipe is connected to both pumps, and is fitted with an arrangement of flexible joints for preventing damage when the vessel is working on the bar at Durban. The lower end of the suction pipe is so arranged that the vessel can plunge about in a 25-foot radius without disturbing the nozzle on the ground.

She has two sets of triple-expansion engines. Steam is supplied from three steel boilers of the Scotch type designed for 180 pounds pressure. An auxiliary condenser and separate combined air and circulating pump are provided for dealing with the exhaust steam from the auxiliary engines. The combined power of the propelling, pumping and auxiliary engines on board is about 4,000 indicated horsepower.

MOTOR BOATS.

PART XV,

BY DR. WILLIAM F. DURAND.

ENDURANCE, OR RADIUS OF ACTION.

The motor boat, in common with all engineering propositions, is necessarily a compromise between conflicting and mutually exclusive requirements. In further illustration of this general law, the relation between the endurance or radius of action and the other conditions of the problem may properly receive brief notice at this point. Endurance, expressed in time, depends, of course, on the capacity of the tanks, or in general on the total amount of fuel supply, and on the demand per hour; while the distance run depends on the time and the speed. Now, supposing a fixed fuel supply, we remember that the power required, and hence the consumption of fuel, will increase as the cube, or somewhat more rapidly than the cube, of the speed. We then have the following relations expressed in algebraic form:

Let v = speed,
H = power,
a = factor relating H to the cube of the speed, and nearly constant for any one boat,
T = total fuel supply,
F = amount required for a given distance,
r = any given distance or radius of action,
h = fuel demand per horsepower per hour,
B = fuel demand per hour,
t = endurance in hours.

Then $B = h\ H$
and $H = a\ v^3$ (nearly)
Hence $B = h\ a\ v^3$ (nearly)

$$t = \frac{T}{B} = \frac{T}{h\,a\,v^3} \text{ (nearly)}$$

$$r = t\,v = \frac{T}{h\,a\,v^2} \text{ (nearly)} \quad \ldots\ldots (1)$$

$$F = B\,t = \frac{B\,r}{v} = h\,a\,r\,v^2 \text{ (nearly)} \quad \ldots\ldots (2)$$

According to (1), the radius of action will decrease as the square of the rate of speed increases. That is, to double the speed will divide by 4 the distance which can be run on a given fuel supply; to increase the speed by 50 percent will divide the distance by 2.25, etc.; while on the other hand, to halve the speed would multiply the distance by 4, etc.

Likewise, equation (2) indicates that, for varying speeds, the total consumption of fuel for a given distance r will increase with the square of the speed, at least over the range for which h and a remain sensibly constant. This means that to double the speed will quadruple the fuel expense for a given distance to be run, with proportional increase or decrease in other cases.

These various relations hold approximately over a fairly wide range of speed, and indicate forcibly the excessive price which must always be paid for high speeds. Below a certain speed, of course, the boat cannot be efficiently operated at all, and at extreme low speeds the increase in the cost of power per unit, as denoted by the factor h, will begin to augment to such an extent that the cost in fuel for a given distance will begin again to increase. The point at which the fuel for a given distance is the least is known as the "most economical speed." For gasoline motor boats, such speed is usually lower than any speed at which the boat would be usually operated, and for moderate fluctuations on either side of the normal speed, the general relations as given above may be accepted as sufficiently accurate for general purposes.

These somewhat surprising results may perhaps be more clearly seen to have a rational basis, by considering that, in accordance with the indications of the formula, the consumption for a double speed will be for eight times the power, or eight times as much *per hour*, and for one-half the time, thus resulting in $8 \times \frac{1}{2}$ or four times the consumption for a given distance. Similarly, for endurance or radius of action, with doubled speed, the distance will be twice as great per hour, but the fuel expense eight times as great per hour, and hence the time with a fixed amount of fuel is one-eighth. Hence we have double speed for one-eighth the time or $2 \times \frac{1}{8}$ = one-fourth the distance.

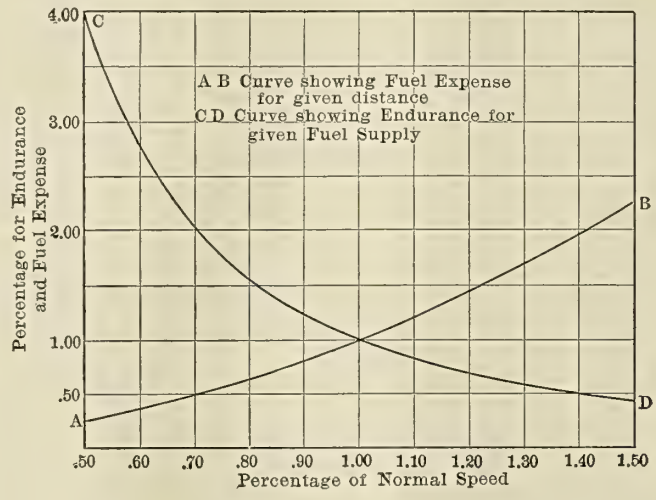


FIG. 62.

In Fig. 62 the indications of these formulæ are shown graphically for a range of speed from 50 percent of whatever may be taken as a standard or normal speed, to 50 percent above such speed.

STABILITY WHEN UNDER WAY AT HIGH SPEED.

The characteristics of the boat which favor stability have been briefly referred to under the head of design. When the boat is under way, it is readily seen that she is subject to a torque or heeling moment exactly equal to the turning moment of the engine. This follows from the general fact that action and reaction are equal in amount and opposite in direction, and hence that if the engine tends to turn the shaft in its bearings carried on the boat as a foundation, so is there an equal tendency to turn the boat about the shaft as an axis or spindle, and in the direction opposite to that of shaft rotation. This turning or heeling moment in motor boats at high speed may be sufficient to represent the equivalent of several hundred pounds placed on the gunwale, and the result may well be a decided list in the direction opposite to that in which the propeller is turning. To compute the weight on the gunwale, equivalent to the turning moment of the engine, we may proceed as follows:

Let H = power developed by engine,
N = revolutions per minute,
M = turning moment,
B = beam of boat in feet,
W = equivalent weight at gunwale in pounds.

Then $M = \frac{33{,}000\,H}{2\,\pi\,N} = \frac{B\,W}{2}$

or $W = \frac{33{,}000\,H}{\pi\,B\,N}$

Thus, for illustration, let $H = 120$, $N = 800$ and $B = 5$.
Then $W = (33{,}000 \times 120) \div (3.1416 \times 5 \times 800) = 317$ pounds.

Such a heeling moment may enter as a serious factor into the question of stability, and may reduce to an uncomfortably low margin what might be otherwise a reasonably abundant provision. The result may be to render such boats in a seaway uncomfortably cranky, and for specially high speeds the question of a large margin of stability is one which should receive due consideration. If the torque were uniform in value, it might be possible to counterbalance its influence by setting the machinery off the center line on the side toward which the crank turns when

passing its top center. Unfortunately, however, the torque varies with the power, and such an arrangement would leave the boat on an uneven keel when at rest or under low speed. It may at least be remembered, however, that the boat will tend to heel opposite to the direction of the rotation of the propeller, and shifting ballast may be provided, or, if there is any tendency toward inequality in the disposition of the weights of the machinery and equipment, the over balance should be so adjusted as to counterbalance as far as may be the effect of the turning moment; that is, the excess weight should come on the side toward which the crank turns when passing the top center.

REACTION OF PROPELLER ON RUDDER.

The somewhat irregular action of the blades of the screw propeller working in the disturbed water about the stern of the boat tends to develop a force deviating the boat from her course. To control this deviation in the case of small, high-speed boats, extra large rudder area should be provided. This deviating force due to the propeller is the result of several components, some of them opposite in character, and the resultant itself may partake of the character of one component or the other, depending on which influence is paramount.

So far as the following wake is concerned its value is the largest near the surface, and it will thus give rise to an increased value of the slip while the blade is on its upper quadrant, and with a right hand propeller it is seen that this would develop a force tending to throw the stern to port. On the other hand, in small, high-speed boats in particular, the propeller blades are likely to be near the surface of the water while on their upper quadrant, and working in water less solid or continuous than for the lower blades. So far as this condition may affect the result, the extra resistance to the motion of the blades will be while on their lower quadrant, and this will develop a force tending, with right hand rotation, to throw the stern to starboard.

With large ships having the conventional form of stern, the former influence as a rule will predominate, and the stern will swing to port with a right hand propeller, while with small boats with the torpedo boat stern, the wake is less pronounced, and the latter influence is the more likely to predominate, throwing the stern to starboard with a right hand propeller. In any case, the provision of rudder area should be generous, and experience will soon indicate the position of the helm for a steady course.

The Armored Cruiser Jules Ferry.

The *Jules Ferry* is the second cruiser of the *Leon Gambetta* class, and has the following particulars: a length on the load water line of 515 feet 1 inch; a beam of 70 feet 1 inch, and a mean draft of 26 feet 10 inches. The corresponding displacement is 12,606 tons. The coal capacity at normal draft is 1,400 tons, and the total bunker capacity is 2,100 tons, besides 100 tons of liquid fuel.

There are three sets of engines, four-cylinder, triple expansion type, operated by steam from du Temple-Guyot boilers (small torpedo tube boiler type).

The interesting features of the trials were:

2 hours with four boilers, 8,500 horsepower, and 16 knots.
6 hours with all boilers, 17,000 horsepower and 19 knots.
24 hours with all boilers, 16,508 horsepower and 18.5 knots.
4 hours with full power, 29,200 horsepower and 22.48 knots.

The coal consumption on six-hour trial was 650 grams (1,433 pounds) per horsepower-hour; on the 24-hour trial it was 744 grams (1.64 pounds); and on the four-hour trial 800 grams (1.764 pounds) per unit of power per hour.

FRENCH ARMORED CRUISER JULES FERRY AT FULL SPEED ON MEASURED MILE TRIAL TRIP.

The cruiser is shown running on the measured mile off Brest, where there is much deeper water than off Cherbourg. The *Leon Gambetta* having made off Brest an average speed of 23.46 knots, it was hoped the *Jules Ferry* could get the same speed.

The battery consists of four 7.7-inch guns in turrets, fore and aft, and sixteen 6.4-inch guns, twelve in turrets on the spar-deck and four in casemates; besides twenty-two 3-pounder guns; there are also five torpedo tubes.

J. Peltier.

Oversea Trade of the United States.

	In American Vessels.	In Foreign Vessels.	Percent American Vessels.
1860	$507,247,757	$255,040,793	66.5
1870	352,969,401	638,927,488	35.6
1875	314,257,792	884,788,517	26.2
1880	258,346,577	1,224,265,434	17.4
1885	194,865,743	1,079,518,566	15.3
1890	202,451,086	1,371,116,744	12.9
1895	170,507,196	1,285,896,192	11.7
1900	195,084,192	1,894,444,424	9.3
1905	290,607,946	2,103,201,462	12.1

—*Marine Journal.*

The White Star Liner Adriatic.

As already announced, the *Adriatic* is about 726 feet long, 75 feet beam and about 50 feet deep. Her gross tonnage will be about 24,000 and her displacement will exceed 40,000 tons.

A noteworthy element of the vessel, besides her size, is that of safety. In addition to the general strength of the structure, the double bottom, extending the whole length of the ship, is a special element of both strength and safety. This double bottom is 5 feet 1 inch deep, except under the engines, where it is 5 feet 10 inches, to give greater rigidity in the neighborhood of the machinery; and besides securing the safety of the vessel, if she should take the ground, it also provides an economical means of carrying ballast. The tanks or cells of the double bottom will hold several thousand tons of water, and the powerful pumps with which the ship will be equipped will enable these spaces to be filled or emptied of water in a very short time.

The *Adriatic* is an exceptionally strong structure. She has nine steel decks. Her frames are composed of steel channel bars, and she has eleven watertight bulkheads, subdividing the vessel into twelve watertight compartments. Many of the shell plates are over 30 feet long and 5 feet wide, and weigh between 3 and 4 tons. A large amount of the riveting throughout the hull has been done by hydraulic machines, the full headed rivets thus driven affording visible evidence of strength, as well as of the quality of the workmanship.

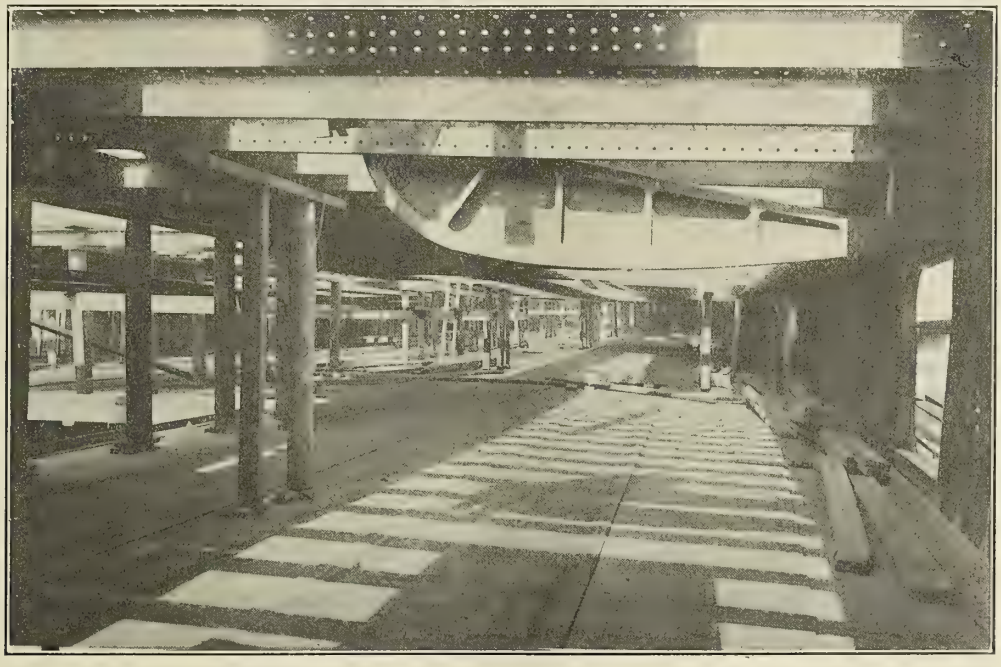
PROMENADE DECK, SHOWING GANTRY CRANE CARRYING TWO SIX-TON HYDRAULIC RIVETERS.

ON UPPER DECK, SHOWING CHANNEL BRIDGE DECK BEAMS AND HEAVILY RIVETED STRINGER PLATE.

The arrangements for cargo will be very complete, there being seven cargo holds, two 'tween deck holds insulated, and two holds fitted as deep tanks. The great feature of the vessel will, however, be the passenger accommodation, the *Adriatic* being capable of carrying about 3,000 passengers, besides officers, engineers and crew amounting to over 400.

The accommodation will be in the usual luxurious style for first class, for whom a large number of separate and distinct suites of apartments are provided, consisting of stateroom, sitting room, bathroom, etc., and full advantage of the huge dimensions of the vessel will be taken in the size and location of the dining saloons, libraries, smoking rooms, etc., and in providing promenade space for first, second and third class passengers. Throughout the whole of the living spaces the three essentials to health and comfort, viz., roominess, ventilation and light, will be in evidence.

The cables and anchors are of gigantic size, the cables being 3⅜ inches diameter, and weighing about 90 tons, while the anchors weigh about 8 tons each. The total number of steel plates in the ship will be close on 20,000, and the rivets nearly 2½ millions in number. The ship is building by Harland and Wolff, of Belfast, Ireland.



ON UPPER DECK OF ADRIATIC, SHOWING HYDRAULIC RIVETER IN POSITION.

Lloyd's Shipbuilding Returns.

Lloyd's Register of Shipping reports under construction on June 30, 1906, in the United Kingdom, a total of 569 merchant vessels of an aggregate of 1,409,456 gross tons, or an average of 2,477, as compared with 472 vessels, of 1,301,457 gross tons, for the corresponding date of the previous year. Of the total at present under construction all but about 1 percent are placed under the heading of steel vessels propelled by steam, the tonnage under this classification being 1,395,294. The present total is within about 4,000 tons of the total reached in 1901, which was the highest on record.

The warships under construction on the same date include 6 battleships and 9 armored cruisers, 17 destroyers and 13 submarines for the British navy, and 3 cruisers and 4 destroyers for other owners. The British total for the 45 ships is 246,595 tons displacement, or an average of 5,480, while the foreign total is 23,020 tons, or an average of 3,289 tons. The grand total is thus 269,615 tons.

Returns for merchant shipbuilding in other countries include figures for France, in which 32,628 tons are under construction; for Germany, with 269,238 tons; for Holland, with 60,661 tons; for Italy, with 80,923 tons; for Japan, with 44,838 tons; for Norway, with 30,483 tons; and for the United States, with 124,237 tons. The figures for the United States do not include the Great Lakes.

TECHNICAL PUBLICATION.

The Naval Pocketbook. Edited by Geoffrey S. L. Clowes. Size, 3½ by 5 inches. Pages, 965; numerous illustrations. 1906, London, W. Thacker & Company, 2 Creed Lane, E. C. Price, 7/6 net.

Since the death of Sir William Laird Clowes, which occurred last year, his son has taken up the preparation of the annual book on the navies of the world, and the volume for 1906 has appeared as usual without any break in the continuity of the series. This work is very complete in its scope, giving lists and particulars of all the warships in service or building for the different navies, and giving in addition, in the rear, outboard profiles and deck plans of nearly all of the important ships of the several fleets. The lists include not only ships valuable for war purposes, but also all other ships owned and controlled by the naval and military authorities of the different powers, and aims to include every vessel of any description which would be liable to give any sort of service, however humble, in connection with military operations. The list of destroyers and torpedo boats is also made complete, the total number included in these lists being over two thousand vessels.

In addition to the list of ships, etc., are given quite complete tables of heavy and light artillery used in the naval services of different powers, the particulars including size, weight and length of gun, weight of projectile and powder charge, and the velocity and energy exerted at the muzzle. There is also a chapter covering torpedoes of various descriptions, and a very important chapter giving particulars of all the dry docks, both naval and mercantile, to be found all over the world. These docks are arranged in geographical order following in each case directly along the coast line from one border of one of the great divisions of the earth to the next. There are also a number of conversion tables between metric and English units, and trial trip tables giving the speeds corresponding with definite measured periods of time on the mile.

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The Development of the United States Navy.

It has been well said that the strength of a naval force lies in the strength of its battleships. Cruisers and small craft have a distinct value in naval operations, but when it comes to striking a decisive blow, to meeting and destroying the force of an adversary on the high sea, the battleship is supreme, and its place cannot be taken with any degree of success by any other class of ship. It is exactly along this line that the development of the United States navy has made its greatest strides since the time of the war with Spain.

There were in service in the United States navy at the time of that war only four first-class battleships, the aggregate displacement of which was 42,210 tons. These ships were the *Indiana, Massachusetts, Oregon* and *Iowa,* and for their day they were probably more powerful than any other battleships afloat, of anything like the same displacement. There were at that time under construction five more battleships, of an aggregate of 57,696 tons displacement, which have since been passed into service, and during the opening days of the war three ships larger than the preceding, being of 12,500 tons each, were authorized. The last of these three, the *Ohio,* received her first commission in October, 1904. The twelve ships in service on that date displaced a total of 137,406 tons, and represented by a large margin the most powerful fighting force which the United States had ever had under its flag.

During the twenty odd months which have elapsed since that time, however, the additions have been of such a notable character, so far as individual and collective power is concerned, that the effective fighting force of the fleet has been well nigh doubled,and, with the completion of three ships now almost ready for service, there is no question that the force will be considerably more than twice as powerful as was the case in the fall of 1904. Of the additions since that date, three are of about 15,000 tons each, and one of 16,000 tons; while two of the former and another of the latter are in such a state of forwardness that if necessary they could be called upon for service within the course of a very few weeks. This group of seven ships comprises an aggregate of 106,740 tons displacement, or an average of 15,250 each, and in point of view of battery power, protection and speed, the ships are without rivals in any naval service in the world. It is true that a number of ships have been planned, both for our own service and for others, which will exceed in military capacity any one of the group above mentioned, and one of these ships has been launched in England, but none of them is in service, and none will be in service for a number of months. As things stand today, therefore, the latest group of ships added to the United States navy are without rivals in power.

This fact will be realized when one compares the gun fire possibilities of these ships, as shown by diagrams on page 256 of our July issue with those of ships of other powers, notably the *Lord Nelson* of the English navy. It is needless to state that the two classes of American ships referred to are represented by the *Virginia* and the *Connecticut.*

The entire group of nineteen battleships comprised within the above category has an aggregate displacement of 244,146 tons, or an average of 12,850. Of this list, fifteen ships with an aggregate of 201,936 tons, or five-sixths of the total, have been completed during the past six or seven years.

New Mammoth Battleship.

Meager reports are at hand covering the features of a battleship designed by Col. Cuniberti of the Italian navy, and said to be now under construction for that navy. This ship is expected to prove a decided advance upon the British *Dreadnought,* partly by virtue of the arrangement of mounting the guns, and partly because of the fact that the guns individually are of greater caliber and much greater power.

From information at hand it appears that the main battery is to consists of four guns of a caliber of 34 centimeters (13.4 inches) each, mounted in pairs in eight turrets. Two of these turrets are forward and aft upon the center line, in accordance with what has been for a long time common practice in warship construction. The other two turrets are mounted, one on either beam, and one of these turrets is considerably forward of the other. The superstructure has been cut away in such a manner as to permit each turret at the beam to train its guns upon the other beam across the center line of the ship, and to cover something of an angle or range of fire on that off side. This arrangement, so far as these two particular turrets are concerned, was adopted twenty years ago in the United States navy, in the designs which resulted in the construction of the two old battleships *Texas* and *Maine,* the bones of the latter of which are now in Havana Harbor. This arrangement of turrets was what was known technically as mounting the guns *en echelon,* which had an advantage, in that it permitted the concentration on either broadside of all the guns of the primary battery, without the coincident disadvantage of cutting away the freeboard at the ends of the ship, as is to a certain extent necessitated by the present method of mounting guns. A disadvantage arises from the great stress occasioned upon the decks on the off side, by the discharge of such heavy ordnance immediately above them, and also from the very restricted arc of fire obtainable on that off side. When used in conjunction with guns on the center line forward and aft, however, it forms a very interesting solution of the general problem of obtaining on a given weight a maximum concentration of broadside fire.

Information is not at hand as to the ballistics of the weapons to be fitted, but as they are entirely new, it is safe to presume that the muzzle velocity will be high, and that, as compared with the 12-inch gun now in such common use, the muzzle energy may be expected to be about proportional to the weights of shells. As the shell of this gun will be of 1,250 pounds, compared with 850 in the 12-inch guns, this means an addition of nearly 50 percent in energy at the muzzle, and, due to the well-known fact that heavy shells retain velocity to a much better degree than do lighter ones, the discrepancy in striking energy at any battle range now considered probable will be decidedly greater.

The 12-inch gun in the United States navy has a service muzzle velocity of 2,800 feet per second, with a corresponding muzzle energy of 46,246 foot tons. On the same basis of velocity, the new guns of the Italian battleship would have a muzzle energy of 68,000 foot tons. At a range of three miles the remaining velocity of the 12-inch gun is 1,967 feet per second, and the energy 22,791 foot tons. With the heavier gun the remaining velocity at three miles is 2,075 foot seconds, and the energy 37,309 foot tons.

An examination of the plans shows that the Italian will be able to bring to bear on a broadside eight guns, discharging an aggregate of 10,000 pounds of metal at once, as against eight guns, with 6,800 pounds of metal, on the *Michigan.* Forward, the Italian can theoretically project at one discharge 7,500 pounds, though probably 5,000 pounds, representing four shells, is all that could safely be counted upon in practice. Against this, the American can fire 3,400 pounds. It is seen that the advantage is due entirely to the use of the heavier guns.

As far back as 1877 the Italian navy took the lead in the introduction of ships of great displacement and high speed, and carrying remarkably powerful batteries. The first two ships with the mammoth guns adopted by the Italians at that time were the *Duilio* and *Dandolo,* each of which carried four 45-centimeter (17.7-inch) muzzle loading guns mounted in pairs on two turntables, each within a barbette. These barbettes were placed *en echelon,* as is the case with two of the turrets in the new ship. Since that time, improvements in materials of construction have led to a decrease in the size of the heaviest guns used, in spite of a continuous increase in the size of ship upon which they were mounted. The step next after the 17.7-inch gun called for a gun of the same caliber as that now introduced for the new ship. This same size was adopted by France and the corresponding size, 13.5-inch, for England; while the United States, in 1892, followed with the 13-inch guns of the *Oregon* class. Further improvements in construction, accompanied by enormous improvements in the ballistic qualities of powders used, resulted in a discarding of these cumbersome weapons for guns of a maximum of 12 inches in caliber, and with considerably greater length, proportionally, than their huge predecessors. Such were the improvements that the present United States 12-inch gun, which was adopted in 1902, has a very decided advantage over the 13-inch guns of the previous regime, as is evidenced by a comparison between the above mentioned energy of the former, with an energy of 33,627 foot tons developed by the latter. The energy per ton of gun is 889 for the 12-inch and 556 for the 13-inch.

There has been no recent disposition to go below 12 inches in caliber, but as yet this size has been considered as amply sufficient for all destructive purposes. It has been so designed and mounted as to be easily manipulated, and breech blocks have been fitted for rapid loading, so that some of the latest results show a rate of fire equal to fifteen times as great as was possible with the older and clumsier pieces of ordnance. There seems to be no adequate reason for reverting to the heavier type, with the necessarily heavier ammunition, heavier fittngs and mountings, and slower rate of operation. The design looks very well on paper, but it is more than likely that it would prove very cumbersome in practice.

ABSTRACT FROM RULES AND REGULATIONS OF BUREAU VERITAS.

EDITION OF 1905.

ARRANGED BY HARRISON S. TAFT.

PART V.

28. Sluice Valves—Ventilators—Freeing Ports.

1. Sluice Valves, Etc.

a. No cock or sluice valve will be allowed on the forward collision bulkhead. When fitted to other bulkheads they are to be so arranged as to work from the upper deck or in the machinery space.

b. A sounding pipe, extending to the upper deck, must be fitted to each watertight compartment. There shall also be a sounding pipe in each wing in double bottom vessels with or without a well. Two such pipes are to be fitted in compartments with but little dead rise to the floors. Doubling plates are to be fitted under all sounding pipes.

c. Suitable air pipes must be fitted to each watertight-ballast tank, extending to upper deck.

d. All lead pipes connecting with the sea are to have cocks or valves at the shell plating. All soil pipes are to be secured to the shell by metal elbows fitted with storm valves.

2. Scuppers and Freeing Ports.

There shall be a proper number of scuppers fitted to all decks, those fitted to the lower decks leading into the bilges by pipes protected by wood coverings. Drain pipes leading into the bilges are also to be fitted to any part of a ship likely to retain water.

TABLE 8.—AREA OF FREEING PORTS.

Length of Bulwarks in the well. Feet	30	35	40	45	50	55	60
Total area of freeing ports on each side. Sq. ft.	9.5	10	10.5	11	11 5	12	12.5

65 feet and above: 1 sq. ft. for each 5 feet length of Bulwarks

3. Ventilators.

They are to be made thoroughly watertight. They are to stand from 2 to 3 feet above the deck and are to be of the same thickness as the side plating of the deck house, but not to be less than ¼ inch in thickness.

4. Cement, Etc.

The bottom plating, frames and inside riveting to the middle of the turn of the bilge and in the peaks, should be coated with some suitable protective cement, worked to the level of the limber holes. All other iron work should have three coats of good oil paint. It is recommended that the inside of water ballast tanks be given a cement wash instead of being painted, the bottom frames and rivets being treated as above stated. The tank top should be cemented in the engine and boiler rooms.

29. Wood Decking, Etc.

1. Said decks are to be of teak or selected pine, fastened to the beams by galvanized screw bolts and nuts, said bolts being dowelled watertight.

2. The deck planking of all second and exposed decks is not to exceed 6 inches in width. The deck planking of orlop decks is to be double fastened if over 7 inches in width.

3. When a wood deck is fitted over a metal deck it can be ½ inch less in thickness than otherwise, but not to be less than 2½ inches thick in any one place. Such wooden decks must also be bolted to the deck plating between the beams. See also sections 33, 34 and 35.

4. Teak decks may be ½ inch less in thickness than required for other woods, but must be not less than 2 inches thick in any place.

5. Butts of deck planks must not come in the same frame space oftener than every fourth plank.

6. Wooden decks are to be calked watertight with at least three threads of oakum.

7. Wooden decks are to be renewed when worn to ¾ of their original thickness.

8. Ceilings. The bottom of a vessel is to be close ceiled in wood up to the upper turn of the bilge. From said upper bilge to the upper deck the sides of the holds are to be sparred ceiled. The ceiling is to be secured to the reverse frames by bolts and nuts. The ceiling on top of floors and tank top is to be laid in hatches, that on top of the tank top being laid on bearers. Through bolts connecting the bearers on top of the tank top to said tank top plating will not be allowed. The side ceiling of holds in vessels engaged in the coal trade can be omitted.

30. Steering Gear and Rudders.

1. The diameter of rudder stocks for high speed steamers is to be determined by the following formula:

$$d = .18 \sqrt[3]{a \times b^2 \times v^2}$$

where d = diameter of stock in inches: a = immersed depth of the rudder in feet: b = the extreme breadth of the rudder in feet: v = the speed in knots. But said diameter must not be less than the tabular diameter.

2. The rudder pintles should not be more than 4 to 5½ feet apart top to top. It is advisable to make them independent of the frame. The stock can be made in one piece with the frame or secured to it by bolts with a key, there being a large coupling on both stock and frame. It should be turned from below the rudder trunk to the head. There shall be a stuffing box or otherwise fitted at the deck.

3. Side Plated Rudders. The rudder frame main piece should taper from the stock to the heel where its sectional area can be made 45 percent that of the stock. The arms or stays are to be spaced 4 to 5½ feet apart. The after part of the frame may taper towards its middle from where it joins the head and the heel,

but it should not be less than 1 to 1½ inches in thickness. Its breadth should be about 60 percent of the stock's diameter with a minimum size of 3 inches. The side plates are to be 1/16 inch thicker than the lower part of bulkhead plating.

4. Single Plate Rudders. The main piece shall be made with a taper from stock to heel where its sectional area may be 55 percent that of the stock. There shall be a groove on the after side of said stock to take the rudder plate. The thickness of said plate should be 1/8 the diameter of the rudder stock, with an allowable range of thickness from 5/8 to 1 3/8 inches. There shall be an arm at each pintle, located alternately on opposite sides of the rudder plate. The sectional area of each arm at its connection to the main frame shall be 50 percent that of the stock, with a gradual taper toward its end, where it can be of the same thickness as the plate. When an arm is located between the pintles in addition to those at the pintles, and the arms are placed alternately on each side of the plate, their area at the main piece may be but 35 percent that of the rudder stock, with the thickness of the rudder plate 1-9 the diameter of the stock, with ½ inch and 1⅛ inch as the two limits for thickness.

5. Balanced Rudders. The diameter of the rudder stock at the head may be 85 percent of the diameter otherwise required, if the rudder area forward of the axis is about 1/3 the total area. With such rudders the diameter at the neck bearing shall be 20 percent larger, the diameter at the heel being 30 percent less than the diameter of the stock required for a non-balanced rudder. The depth of the heel bearing is to be not less than its own diameter, that of the neck bearing being 1½ times its diameter. The main piece should taper from the neck towards the heel and from the neck to the stock. This data is for rudders which are in depth between the neck and heel bearing about 24 times the tabular diameter of the rudder stock. Spacing and size of stays, including thickness of plate, is to be as for a single or a side plate rudder respectively as above.

6. All rudders should be so arranged that they can be unshipped when the vessel is afloat.

7. The stops should be fitted to stop the rudder at from 35° to 40° from center line. Said stops should be fitted on the deck besides being fitted on the rudder itself.

8. Steering Gear. The radius of the quadrant shall be determined by the formula: $R = 6\,(D + 2)$: the diameter of the steering chains by the formula: $d = \frac{D+1}{8}$, and of the steering rod by: $d_1 = \frac{D+1}{6}$: where in $D =$ diameter of rudder head in inches: $R =$ radius of quadrant feet: $d =$ diameter of steering chains in inches; and $d_1 =$ diameter of steering rods in inches.

The eye should equal in depth the diameter of the rudder head; its outside diameter being 1.8 times the diameter of said head.

31. Life Boats.

Gross Tonnage	Under 100	100 under 400	Over 400
No. of Boats	1	2	At least 3

All vessels to have a boat capable of carrying a stream anchor.

32. One, Two, and Three Deck Vessels.

1. Such vessels include all those having their upper deck running from stem to stern without interruption and not otherwise belonging to the spar or awning deck type.

2. Depth for regulating scantling to be found as given in section No. 1. The reduction of 85 and 75 percent respectively will also be allowed in three deck steam vessels where hold beams are dispensed with if web frames or deep framing is substituted for same.

3. Two and three deck vessels of 22 or more feet in depth to the upper deck must have their upper and second deck entirely plated over or covered with wood.

4. When a complete or partial steel deck is required it is to be fitted to the upper deck. When one complete and one partial steel deck are fitted the former is to be laid on the upper deck, the latter on the second deck.

5. When deck houses of other than limited dimensions are erected on the upper deck of three deck vessels partial bulkheads or otherwise must be fitted between decks.

33. Spar Deck Vessels.

1. Including vessels carrying light cargo in the upper 'tween-decks. Said vessels having only light deck erections, and at least two laid decks.

2. In no case is the athwartship number to be less than 45 or the longitudinal number less than 77,500.

3. If deck houses of other than limited size are erected on the spar deck partial bulkheads or otherwise must be fitted between decks. See also table 2.

4. The upper and second decks must be permanently plated over or covered with wood. A reduction of ½ inch from tabular thickness will be allowed on the deck planks of said decks, but no planking under 3 inches will be allowed when no plated deck is fitted.

5. When a complete or partial deck is required it must be worked on the upper deck. With one complete and one partial deck, the complete deck must be worked on the upper deck, and the partial deck on the deck immediately under it.

6. Depth for determining deck stringers to be measured to upper deck.

7. In vessels whose depth is more than 1-14 of length the deck stringers and ties of the main deck can be 1/16 inch less in thickness than the tabular thickness, but not to be under 11-32 inch thick amidships and 5-16 at ends.

34. Awning Deck Vessels.

1. In these vessels a light deck is fitted over the second deck from forward to aft to shelter passengers or light cargo. If the top sides between the awning deck and the second deck are left open for a certain length before and abaft the midship section or for the whole of the vessel, said vessel is termed a "shade deck vessel." Partial awning deck vessels are those where the awning deck is not continuous from forward to aft and which have a raised forward or after deck.

2. Hatchways on second deck are to be fitted as if on an exposed deck, but depth of coaming need not exceed 12 inches.

3. The awning deck sheerstrake is to be $\frac{1}{16}$ inch thicker than the side plating next below it in all cases.

4. All openings in the awning deck side platings must be efficiently compensated for.

5. When a curved gunwale is adopted the stringer plate must be laid flat on the beams for its full tabular breadth.

6. Longitudinal and diagonal tie plates must be fitted to the awning deck and the deck below when said decks are not plated. The second and upper deck must be plated or covered with wood.

7. A reduction of $\frac{1}{4}$ from the thickness of the second deck planking will be allowed for the awning deck, but no plank to be less than $2\frac{1}{2}$ inches thick.

8. A required partial or complete deck is to be fitted to the second deck. With more than one plated deck the thinnest one is to be fitted to the awning deck.

35. Raised Deck Vessels.

1. In this type the upper deck is interrupted and raised at the after end, the forward part of the deck being fitted with a forecastle built in the ordinary manner, or raised in the same manner as the quarter deck.

2. The height of the raised deck above the upper deck is to be added to the molded depth to the upper deck in determining the arrangement of lower deck beams, hold stringers and reverse frames in way of the raised deck.

3. A maximum load must be fixed for vessels built with both a raised quarter and a raised foredeck.

4. *a.* The thickness of the side plating of the raised deck above the main sheerstrake is to be the same as required for the side shell plating. Said side plating shall extend 2 or 3 frame spaces beyond the break.

b. If the length of a raised deck exceeds $\frac{1}{4}$ the vessel's length the side plates at the break are to be $\frac{1}{8}$ inch thicker; the adjoining plates before and abaft being $\frac{1}{16}$ inch thicker than otherwise.

c. If a gangway or cargo port interferes with the above arrangement the sheerstrake is to be worked double for at least 20 feet in way of the brake.

d. In vessels with both a raised quarter and a raised fore deck the upper deck sheerstrake is to be worked continuously from the stem to stern, being $\frac{1}{8}$ inch thicker at each break than otherwise.

5. Wood decks can be $\frac{1}{2}$ inch less in thickness than otherwise when the length of the raised deck is less than $\frac{1}{4}$ of the vessel's length, but they must not be less than $2\frac{1}{2}$ inches thick in any place.

6. In way of a break both the raised and the main decks are to be plated over from stringer to stringer, so as to provide proper means of attachment for the brackets between said decks.

7. *a.* When the length of a raised deck is over $\frac{1}{4}$ the vessel's length, the stringer plates of said deck are to continue for three frame spaces beyond the break, gradually tapering for said length to the width of the main rail.

b. The upper deck stringer is also to extend beyond the break bulkhead for three frame spaces, being clipped to the side plating for said length.

8. *a.* In vessels with both a raised quarter and a raised fore deck the upper deck stringer must continue under the raised deck for a distance equal to three times its width with a gradual taper from full width to that of the frame for said distance. It should be clipped to the shell plating.

b. In said vessels the raised deck stringer is to be worked continuously, being secured to the shell by a single angle bar.

9. No doors will be allowed in the end bulkheads of raised decks or of bridgehouses.

36. Poops: Forecastles: Bridgehouses: Deck Houses.

1. The side plating of the poop is to extend forward of the front of the poop 2 or 3 frame spaces; the plates at the break being increased by $\frac{1}{16}$ inch in thickness. These requirements apply to both ends of a bridgehouse.

2. *a.* When the length of any of these structures exceeds $\frac{1}{4}$ of the vessel's length, the sheerstrake is to be doubled and the stringer plate increased by 20 percent in thickness for at least 20 feet in way of the front of a poop, the after end of the forecastle and of both ends of a bridgehouse.

b. When the combined length of a poop and bridgehouse, of the poop and raised quarter deck, or of either one of said structures exceeds 2-5 of the vessel's length, when said vessel's longitudinal number exceeds 125,000, the upper sheerstrake is to be doubled for $\frac{1}{2}$ length amidships with plating equal to that of the strake next below; or its thickness increased by $\frac{1}{2}$ of its tabular midship thickness for same length. If the bridge side plating and stringers are increased over at least 2-5 of the vessel's length said increase of sheerstrake can be omitted.

c. When the combined length of any two of these structures or the length of any one exceeds $\frac{1}{2}$ the vessel's length in a vessel whose longitudinal number exceeds 125,000 said doubling of the sheerstrake, etc., is to extend for $\frac{3}{4}$ of the vessel's length amidships.

3. With a curved gunwale the stringer must lay flat on the beams for its full width and the gunwale strake brought up to meet it.

37. General.

1. All steel and iron vessels should be examined in dry dock at least once a year.

2. All metal parts of a vessel and all wooden decks which are worn to less than ¾ of their original required thickness must be removed and replaced by material of the proper requirements.

3. All anchors, chain cables, rigging, etc., must be replaced when their sectional area or weight has been reduced to ¾ of their original required value.

38. Spacing of Rivets.

	Diam.
1. Center of rivet from edge of a plate or angle bar (not less than)	1½
2. Center to center of rows; zigzag riveting	2
3. Center to center of rows; chain riveting	3
4. Single and double riveted butts; two inner rows of treble riveted butts with single straps; single riveted seams of shell plating; butts and seams of wateams of shell and bottom plating; treble riveted	
5. Single riveted seams of decks; double riveted sertight bulkheads, double bottoms, etc	3½
lapped butts	4
6. Treble riveted double strapped butts; double riveted seams, except those of the shell and double bottom plating; quadruple riveted butts	4½
7. Forgings; connections of floors and frame brackets to the center girder and tank top margin plates: engine and thrust block foundations; framing immediately below same; beam knees (see 12 below); side plated rudders	5
8. Third row of a treble riveted single strapped butt; connection of shell plating to frames and stringers from the keel up to the load line for about 20 percent of the vessel's length aft from stem when the longitudinal numeral exceeds 250,000	5¼
9. Frames and reverse frames to each other and to floors; frames to shell plating; angle bars of beams, keelsons and hold stringers; bulkhead stiffeners, etc	7
10. Bulkhead stiffeners arranged entirely inside of a deep water ballast tank	5 to 6
11. Stringer plates and deck plating to beams	8

12. At least four rivets are to be put in each side of a beam knee, one of which in case of a plate knee is to pass through the beam itself.

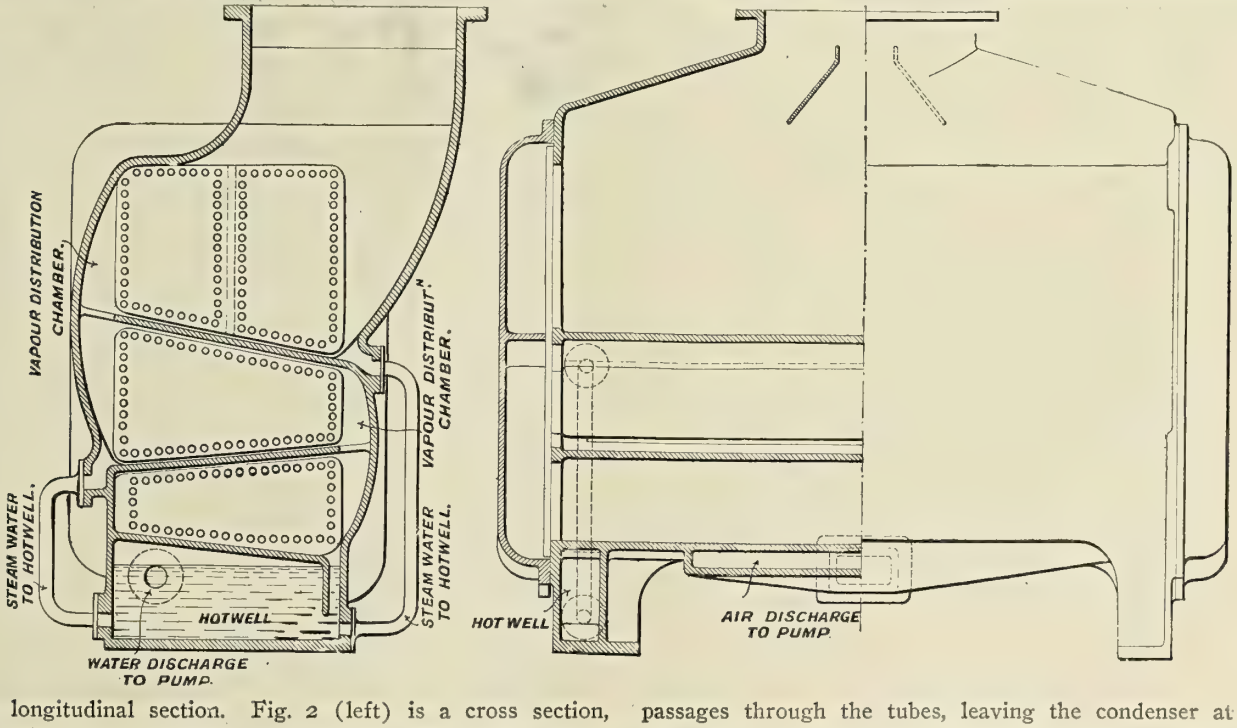
(To be continued.)

ENGINEERING SPECIALTIES.

The Contraflo Condenser.

A condenser of modern design which is rapidly coming into extensive use both for land and marine purposes is the Contraflo condenser. Fig. 1 (right) is a half elevation and half vertical longitudinal section. Fig. 2 (left) is a cross section, showing the water drainage arrangements. The steam enters the condenser at the top and passes in succession through the three compartments, being conveyed from one to the other of these by the tubeless passages or distributing chambers shown in Fig. 2. The air is discharged to the pump from the bottom of the condenser; but the water of condensation is dealt with separately, each compartment having its own independent pipe or passage for drawing off the water to a hotwell situated at the bottom of the condenser, or elsewhere, as preferred.

The circulating water enters at the bottom, and makes several passages through the tubes, leaving the condenser at the top. The general direction of the steam is thus opposite to that of the water, but the actual path of the steam through the several compartments is at right angles to the flow of the water; hence the name: Contra-flow.

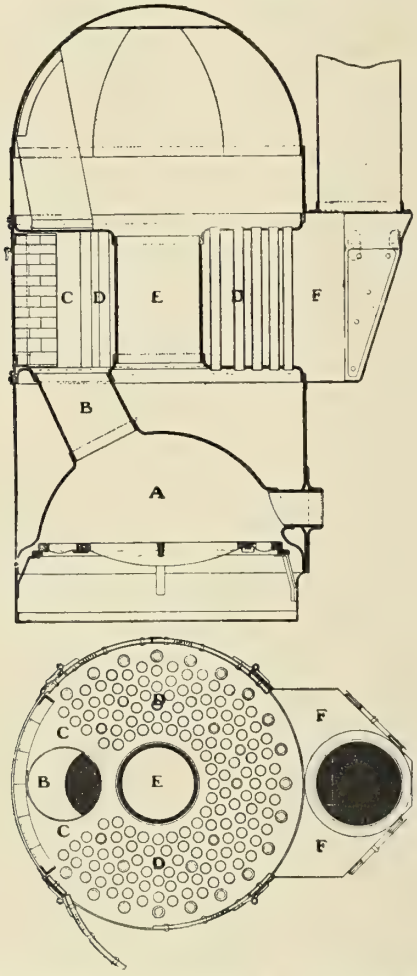


The admission of the steam at the top of the condenser and the withdrawal of the air from the bottom allows of the highest vacuum being obtained under given conditions, as has been proved by experience; and the placing of the water inlet and outlet respectively at the bottom and top enables the air just before it leaves the condenser to come into contact with the coldest tubes, and thus to reach the air pump with a minimum volume and containing a minimum amount of water vapor. At the same time the arrangement promotes economy of water, and it also allows of a high hotwell temperature being obtained, as the top compartment, which supplies most of the hotwell water, is subjected to the least cooling action.

The three compartments of the condenser are of continually diminishing section so that as the volume of the steam is reduced through condensation, its velocity remains approximately constant. The tubeless passages are also successively reduced in maximum cross-section to suit the diminishing volume of the steam. The steam is thus distributed equally over the whole cooling surface, and passes through the condenser with uniform velocity in smooth easy-flowing stream lines.

The Riley Patent Water-Tube Boiler.

This boiler, which is of the water-tube type, has been designed and patented to meet the demands for a vertical donkey boiler, which is simple in construction, reasonable in price, durable, easily cleaned and repaired, and economical in fuel. As will be



seen from the illustration, the shell of the boiler is cylindrical, and is made up of two plates, the lower one, into which is placed a circular tube plate and the firebox, and the upper one, to which is attached the crown of the boiler and the upper tube plate. The space between the tube plates, which is closed in by a fire brick back, asbestos-packed doors, and the smokebox, and is the full length of the tubes, forms a large and free combustion chamber.

The firebox A, is of the hemispherical form; the products of combustion are led by an incline tube B, into the combustion chamber C, and after passing at right angles among the small tubes D, and being split up by the central tube E, are then discharged into the smokebox F at low temperature.

All parts of the boiler are fully accessible for cleaning, the occasional use of a steam blast through the casing doors being said to be all that is necessary to keep the tubes and tube plates free from soot and dust. Every part of the boiler exposed to the hot gases is covered with water, and can be easily repaired or renewed. All tubes are straight, vertical and of equal length, and can be withdrawn into the upper steam and water space.

The boiler has good circulation, a large water area for the liberation of steam, low funnel temperature and high efficiency of heating surface. Easy access to the lower end of the tubes and to the firebox top is obtained by means of the large central tube, which forms a passage through the combustion chamber. The boiler is marketed by Riley Bros., Limited, Stockton-on-Tees, England.

A Patent Hawse Pipe.

From time to time there has been serious damage caused by the projecting anchors of ships. The hawse pipes also have been

the source of considerable trouble, and at times have been dangerous for the reason that a ship, especially one heavily loaded

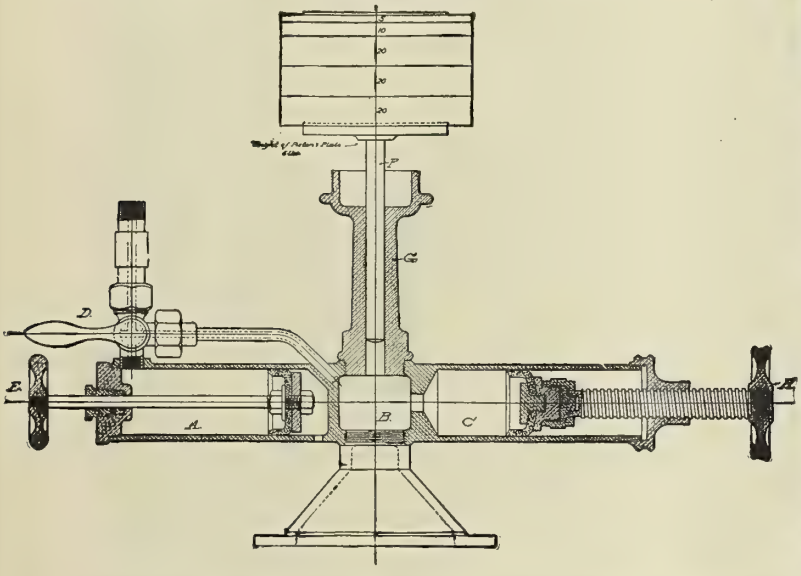
and running in a head sea, has had the water forced up through the pipes and into the forward part of the vessel. At times a sufficient quantity of water has been taken in through the hawse pipes to seriously endanger the ship.

The hawse pipe used on the steamer *Wm. P. Snyder,* built by the Great Lakes Engineering Works, of Detroit, Mich., the bow of which is illustrated herewith, is so constructed as to admit of the flukes of the anchor being drawn inside the hawse pipe, therefore leaving nothing projecting excepting the base of the anchor. This not only removes from the outside of the ship the dangerous projection of the anchors generally in use, but it also closes over the end of the hawse pipe, thus preventing a ship's taking water through the hawse pipes when running in a head sea.

The American Gauge Tester.

A dead weight gauge tester, with improvements which make principally for increased facility in handling the apparatus, has been brought out recently by the American Steam Gauge & Valve Manufacturing Company, Boston, Mass. The claim is made that it possesses all the advantages of the mercury column, inclosed in a much smaller space, and that it can be relied upon to be absolutely accurate at all times.

The sectional view shows the principal parts of the pump to be a chamber B, connected directly with the gauge to be tested, and the cylinder G, containing the piston F, upon which the



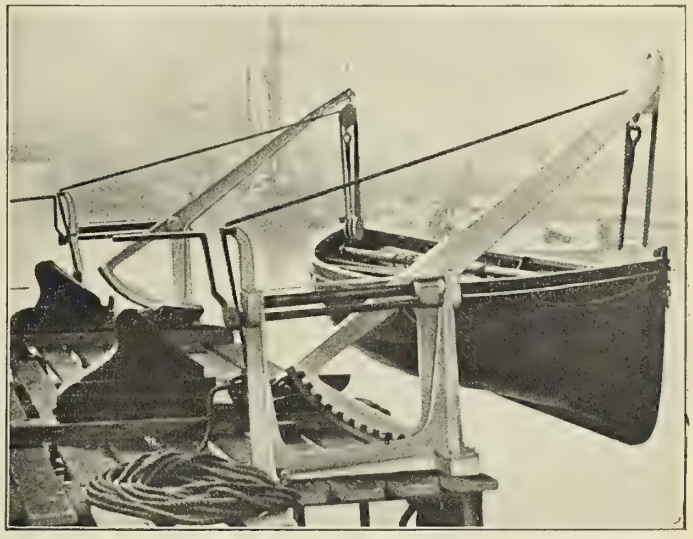
weights act, the cylinder C having a screw plunger for raising the piston F under weight and the auxiliary oil chamber A having a plunger for filling the connection between the gauge and the main chamber G through the three-way cock D. The weights and the area of the piston F are proportioned to produce directly on the gauge to be tested the pressures indicated on the weights. The oil is contained within the pump at all times, eliminating the necessity of pouring it in and out before and after testing.

Before disconnecting the gauge the handle of the cock D is turned down and the handle E is pushed in. All oil is thus drawn off or drained from the gauge tube into the chamber A, preventing spilling of oil when the gauge is disconnected.

Welin Quadrant Boat Davits.

The swinging davits now in general use on merchant ships are not a particularly satisfactory means for launching lifeboats at sea, the manipulation of the davits being effected by the pushing and pulling of the boat. To offset the disadvantages due to the older form, a device has been patented by Alex Welin, which is illustrated by a cut on this page. In this device the lower end of the davit is made into a toothed quadrant, of which the teeth fit into corresponding meshes in the base of the outfit. The center of the quadrant forms a fulcrum, about which the whole is rotated, while at the same time this center is traversed outboard for the purpose of launching the boat. The motion is such as to carry the boat out over the side, by both the traversing and the rocking effects, the operation being performed by means of a screw gear working through the fulcrum. One man at each end of a boat can handle the apparatus, even when it has a considerable load upon it.

This device has been adopted on a number of the most recent

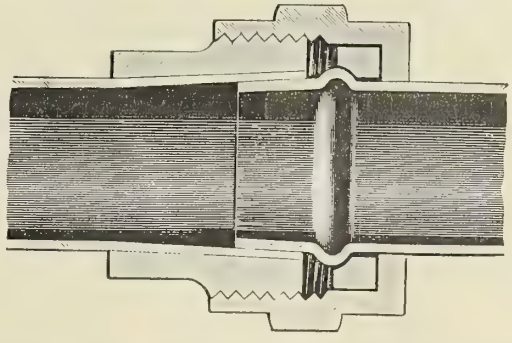


steamships, prominent among which might be mentioned the *Cedric, Victorian, Virginian* and *La Provence,* and was illustrated in connection with the latter ship on page 223 of our issue for June. The device is placed upon the market by Mr. Welin, at Hopetoun House, Lloyds avenue, London, E. C., and is handled in the United States by A. P. Lundin, 49 Wall street, New York City.

A Patent Compression Pipe Joint.

The "Compression" joint is designed for connecting copper, brass, and other tubes of light gage, to avoid the difficulty of screwing. One pipe end is forced into the expanded end of the opposing pipe, compressing it into a taper form on the spigot end, which beds itself firmly into the expanded end, making a perfect metal to metal joint, no white lead or other jointing material being required.

In an ordinary union, where two pipe ends have to be screwed, and then a joint made in the union itself, it makes practically



three joints. Where pipes are united together by means of the "Compression" joint, the connection is complete with only one joint, the pipe ends being forced into each other. This joint can be made in considerably less time than by other means, effecting a great saving in labor, and can be easily disjointed for cleaning. The fittings are placed upon the market by J. M. Leigh & Son, 67 Deansgate, Manchester, England.

PERSONALS.

The Right Honorable W. J. Pirrie, chairman of Harland & Wolff, Limited, of Belfast, has been made Lord Pirrie of Belfast. The new peer was born in 1847 at Quebec, and was educated at the Belfast Royal Academical Institution. He has been connected with the shipyard since 1862, having been made a partner in 1874.

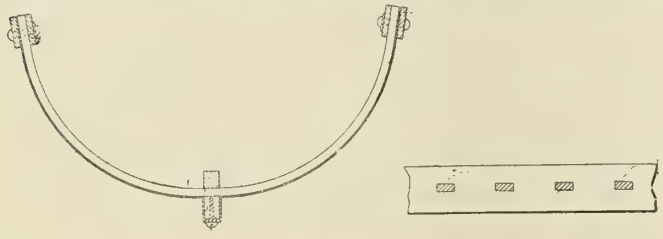
On the birthday of His Majesty, King Edward VII, June 29th, Mr. John Williams Benn, senior partner of our publishing company, 8 Finsbury Square, London, E. C., received a knighthood, and became Sir John Williams Benn.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

819,784. METALLIC BOAT. WILLIAM H. MULLINS AND WILL C. HARE, SALEM, OHIO.

Claim.—6. In a motor-driven boat, the combination of a permanent rigid frame comprising a keel and a bow-piece and stern-pieces forming



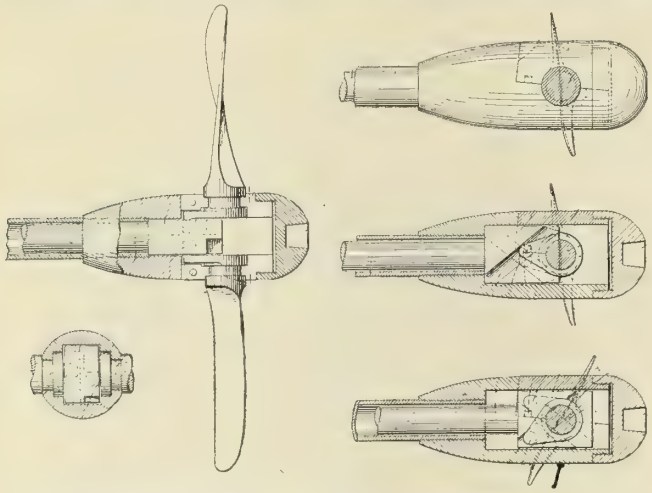
continuations thereof, gunwales and connecting-ribs, and a metal shell covering said frame and secureed thereto at the gunwales and keel and bow-piece and stern-piece only. Six claims.

821,925. POWER TRANSMISSION FOR EXPLOSIVE-MOTOR-DRIVEN BOATS. WILLIAM E. COLLIER, MUSKEGON, MICH. ASSIGNOR TO RACINE BOAT MFG. CO., MUSKEGON, MICH. A CORPORATION OF MICHIGAN.

Claim.—1. A propelling mechanism for boats comprising an explosive-engine, its crank-shaft, a valve mechanism for controlling the supply of explosive admixture to the engine, an electric ignition mechanism provided with a member which is adjustable to change the sparking period, a propeller-wheel provided with blades which are angularly adjustable to vary the pitch thereof, an endwise-movable propeller shaft connected with the propeller-blades and acting by its endwise movement to change the pitch of said blades, a movable cam-plate, operative connections between said cam-plate and said propeller-shaft, producing shifting movement of said cam-plate in the endwise movement of said propeller-shaft, and operative connections between said cam-plate, the valve mechanism and the adjustable member of the ignition mechanism, whereby the propeller-blades, the valve mechanism and the ignition mechanism are adjusted in unison. Five claims.

822,064. REVERSIBLE OR FEATHERING SCREW-PROPELLER. HARRY K. MILHAM, TWICKENHAM, ENGLAND.

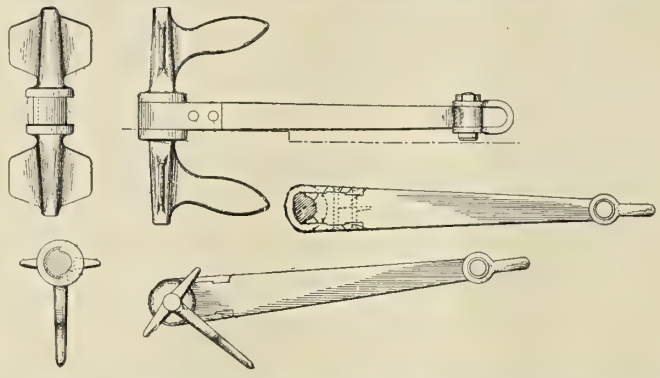
Claim.—1. In reversible or feathering screw-propellers; the combination with propeller-blades having spindle ends, and a hollow hub to receive the spindle ends of said blades said hub having an aperture through its wall extending forwardly from the rear end of same, the planes of the longitudinal edges of the wall of said hub at said aperture containing the



axes of said blades, said edges each having a semicircular recess at said axes adapted to receive half of a blade-spindle, and the forward edge of the wall of said aperture being inclined rearwardly; of a removable cover for said aperture, the longitudinal edges of said cover having semicircular recesses each adapted to embrace the remaining half of each blade-spindle, the forward edge of said cover being formed to contact and interlock with the forward edge of the wall of the hub at said aperture, means for detachably securing the rear end of the cover to the hub, mechanism contained within the hub for adjusting the blades about their axes, a tubular driving-shaft to carry the hub, and a rod passing through the driving-shaft for operating the blade-adjusting mechanism. Five claims.

822,097. STOCKLESS ANCHOR, GEORGE W. BOWDEN, RIDLEY PARK, PA.

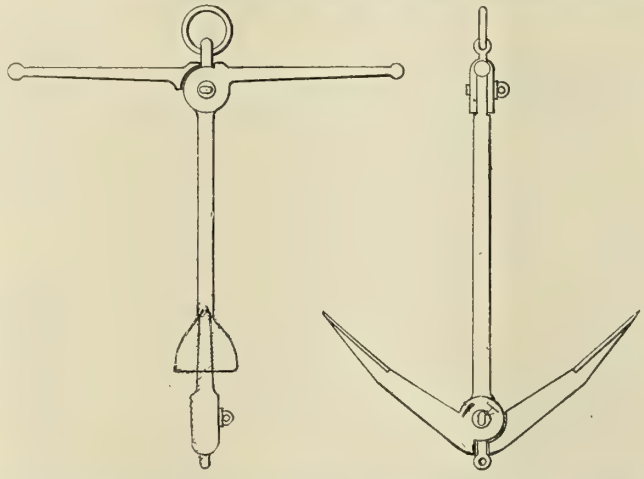
Claim.—1. In a stockless anchor, the combination with the shank, of



a concaved seat on the lower end of the shank and stops formed on the shank to one side of and above the said seat. Eleven claims.

822,420. ANCHOR. WILLIAM L. ADAMS, SOUTH PORTLAND, MAINE, ASSIGNOR TO GEORGE H. GRIFFEN, PORTLAND, AND JOHN E. FISHER, SOUTH PORTLAND, MAINE.

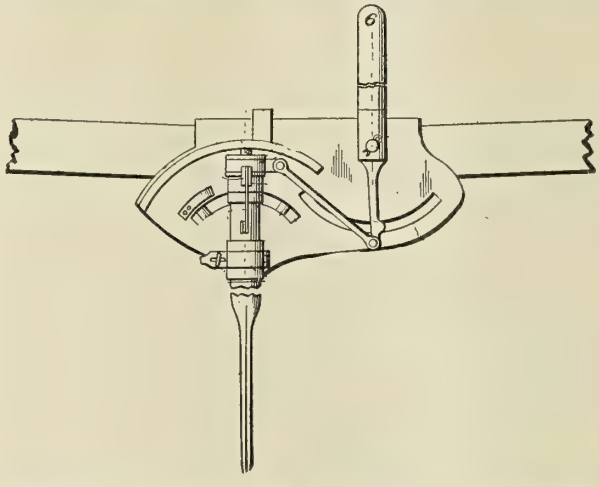
Claim.—2. In a folding anchor, the combination of a shank having near the lower end a circular plate with plain central apertures, arms pro-



vided with circular ears with central openings adapted to register with the opening in said plate, one of said openings being threaded, and a shoulder upon each arm beneath said ear adapted to contact with the side of the lower end of said shank, and a threaded pin for coupling the parts together. Four claims.

823,075. BOW-FACING OAR. JOHAN PETRICH AND LOUIS DULOVES, CHICAGO, ILL.

Claim.—1. In a bow-facing oar, the combination with a hinged, spring-balanced, supporting-plate, of an oar pivotally mounted on said plate, a segmental guide-bracket to receive and support the inner end of said oar,



an operating-lever pivotally mounted on said plate, a link pivotally connected to the outer end of said lever, antifriction-rollers mounted on said lever, a strap loosely connecting the inner end of the oar with the opposite end of said link, means to feather said oar at the end of the stroke, and means to restore the same to an operative position when brought back for a new stroke. Four claims.